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Ambient Perchloroethylene Levels Inside Coin-Operated Laundries with Drycleaning Machines on the Premises

PEDCo-Environmental, Inc.
Cincinnati, OH

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AMBIENT PERCHLOROETHYLENE LEVELS INSIDE COIN-OPERATED LAUNDRIES WITH DRYCLEANING MACHINES ON THE PREMISES

by

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U.S. ENVIRONMENTAL PROTECTION AGENCY
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16. ABSTRACT

In this study, ambient perchloroethylene (PERC) levels were measured inside and in the vicinity of six self serve laundries containing coin-type dry cleaning operations. Inside two of the laundries, evaluations of organic vapor monitoring badges were performed in addition to the basic monitoring effort. Special tests were conducted during this study to measure PERC emissions from dry cleaned clothing and to measure PERC levels in an apartment above one of the tested laundries. The data obtained showed that PERC levels inside laundries were consistently much higher than outdoor ones. Usually the indoor levels were higher by a factor of greater than 100. Similar PERC levels were found in an occupied apartment directly above a laundry as in the laundry itself, and the introduction of dry cleaned clothes into a separate, enclosed living space was followed by a significant increase in PERC concentration that persisted for several days. Evaluations of organic vapor monitoring badges showed large differences between levels of PERC found by badges and levels found with the charcoal tube method.

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SECTION 1

INTRODUCTION

The purpose of this study is to gather data on perchloroethylene (PERC) levels inside self-service laundries with coin-operated drycleaning machines. Data of this nature are required to determine PERC exposure levels within these establishments.

The Environmental Monitoring Systems Laboratory of the U.S. Environmental Protection Agency (EPA) sponsored this study in conjunction with the U.S. Consumer Product Safety Commission. This study resulted from a request by the Interagency Regulatory Liaison Group. PEDCo Environmental, Inc., performed the field testing and was the prime laboratory for performing analyses of the field samples. The laboratories of Research Triangle Institute (RTI) and TRW Corporation analyzed a designated portion of the field samples to reduce the amount of time required for analysis. Research Triangle Institute coordinated quality assurance testing of spiked samples by the three participating laboratories.

The study was performed at six laundries (Sites A through F) in the vicinity of Washington, D.C., during August and September 1980. Testing consisted of seven consecutive days of sampling at each laundry. Outdoor samples were collected concurrently in the vicinity of each laundry to provide background PERC data. A separate study was performed to determine PERC emissions from freshly drycleaned clothes placed in a closed living space (Site G) for several days.

Sampling was performed with 150-mg charcoal tubes manufactured to meet standards of the National Institute for Occupational Safety and Health (NIOSH). At two laundries, indoor sampling included use of organic vapor monitoring badges to obtain data for future evaluation of the comparability of the badges to the charcoal tube method. Analyses were performed by desorbing samples in a suitable solvent and determining the PERC concentration by gas chromatographic techniques. Concentrations of PERC were then calculated on a volume-per-volume basis. An extensive quality assurance program was undertaken to ensure the accuracy and precision of results.

Section 2 summarizes the overall results of this study. Sections 3 through 7 discuss charcoal tube sampling, results, and quality assurance. Section 8 concerns badge sampling, results, and quality assurance.

The level of effort involved in this study did not include determination or collection of data for all factors possibly influencing public exposure to PERC in the establishments tested. The following limits must be considered in evaluating the data:

> All PERC data collected are time-weighted averages (TWA's). Actual peak and low concentrations in the laundries during testing may have varied considerably from the values determined in this study.
>
> Records of total customer traffic and total machine usage were beyond the scope of this study.
>
> Information from similar studies had suggested late August and early September to be representative of peak drycleaning operations. This was determined not to be the case at the laundries tested. (Clothing borrowed from Goodwill Industries was drycleaned at the laundries on a scheduled basis partly to compensate for this.)
>
> Because the study was performed during a relatively high-ventilation season (summer), results may be low compared with PERC levels during low-ventilation seasons (late fall and winter).

SECTION 2

SUMMARY

THE STUDY

The purpose of this report is to describe a data gathering study concerning ambient perchloroethylene (PERC) levels inside laundries containing coin type dry cleaning machines. PEDCo Environmental, Inc. performed the field work, which involved taking outdoor 24-hour samples and indoor 8-hour samples for 7 consecutive days at each of six laundries. Samples were taken on standard 150 mg charcoal tubes. These adsorb organic vapors from air which is drawn through them. Some organic vapor monitoring badges were exposed during charcoal tube sampling to evaluate the comparability of the two methods. After sampling, tubes and badges were taken to Cincinnati, under 0°C storage, for distribution among three analysis laboratories: PEDCo (Cincinnati), Research Triangle Institute (North Carolina), and TRW (North Carolina). Following a prearranged schedule, triplicate field samples were either split for distribution between laboratories or sent to one laboratory only. Laboratory analysis results were used to determine PERC levels, which were reported as parts per billion (ppb) for all field samples.

An additional test using charcoal tubes was performed to measure the PERC levels inside a living space before and after introducing freshly dry-cleaned clothing to it.

The techniques used for sampling and for analysis by gas chromatography are given in detail. Precision and accuracy assesments were made as follows:

(1) One hundred charcoal tubes and 52 badges were spiked with PERC and analyzed by the participating laboratories. The performance of each laboratory is reported in terms of percent recovery efficiency for each type of sample.

(2) Sixty-four desorbed samples were analyzed in duplicate or triplicate by the laboratories. The performance of the laboratories was reported in terms of coefficient of variation (C.V.) for each type of sample.

(3) Eighty-four sets of collocated tubes and 83 sets of collocated badges were analyzed, with performance reported in terms of C.V.

(4) Front and back sections of 38 charcoal tube samples were analyzed separately. Results were reported in terms of average percent PERC breakthrough.

Additional factors affecting precision and accuracy that were noted but not used for computations were:

(1) Variations between initial and final charcoal tube sample air flow rates were recorded.

(2) Initial and final exposure times for badge samples were recorded to ±10 minutes for each 8-hour period.

RESULTS

The values found by charcoal tube sampling demonstrated that indoor ambient PERC concentrations were higher than outdoor concentrations at all sites. As Table 1 indicates, average daily indoor concentrations ranged from 75 to 14,000 ppb, whereas average daily outdoor concentrations ranged from 0.13 to 6.7 ppb. In most cases, indoor concentrations were more than 100 times higher than outdoor concentrations. As indicated, average daily indoor concentrations varied significantly from site to site and from day to day at each site. Differences between laundries and between daily operations at each laundry probably account for these variations.

TABLE 1. SUMMARY OF AMBIENT PERC CONCENTRATIONS INSIDE AND OUTSIDE LAUNDRIES (ppb)

	Indoor PERC concentration			Outdoor PERC concentration			N
	Lowest daily average	Highest daily average	7-day mean	Lowest daily average	Highest daily average	7-day mean	7-day I/O[a]
Site A	91	200	130	0.86	6.7	3.3	59/62
Site B	75	700	320	0.34	3.9	1.4	28/29
Site C	250	2,700	1,300	1.2	4.5	3.6	33/30
Site D	464	3,800	1,500	1.3	4.4	2.5	33/33
Apartment above Site D	620	5,800	1,800	1.3	4.4	2.5	34/33
Site E	1,900	14,000	8,600	0.13	5.0	1.5	62/49
Site F	330	3,100	1,300	0.27	4.0	2.0	30/35

[a] 1/10 signifies "N" for 7-day means as Indoor/Outdoor, where N is the total number of measurements used in arriving at mean values.

Measurements of PERC emissions from drycleaned clothes in a closed living space showed that PERC concentrations were highest (102 ppb) during the first day of exposure. As Table 2 shows, PERC concentrations then tapered off to a level (~20 ppb) that remained constant for several days.

Tests performed in an apartment above Site D showed average PERC concentrations (~1800 ppb) comparable to those in the room immediately downstairs (~2000 ppb), which contained drycleaning machines. Average PERC concentrations in the apartment were higher than those inside the laundry as a whole (~1500 ppb).

Total method precision, based on reproducibility of results obtained from collocated sampling points, showed a coefficient variation of approximately 20 percent for both indoor and outdoor sampling. The precision estimates are presented in detail in Section 7 of this report.

Results of the comparison tests between charcoal tubes and organic monitoring badges are presented in Section 8.

TABLE 2. SUMMARY OF AMBIENT PERC CONCENTRATIONS INSIDE A CLOSED LIVING SPACE WHERE DRYCLEANED CLOTHING WAS INTRODUCED

Test day	Comments	Mean PERC concentration, ppb
1	No drycleaned clothing[a]	0.21
2	No drycleaned clothing[a]	0.18
3	First day of exposure[b]	102
4	Second day of exposure	22
5	Third day of exposure	17
6	Fourth day of exposure	25
7	Fifth day of exposure	16
8	Sixth day of exposure	14
9	Seventh day of exposure	6.2

[a] Values obtained were used to establish baseline PERC concentration.

[b] Drycleaned clothing was introduced at beginning of this 24-hour period.

SECTION 3

SAMPLING PROTOCOL

SAMPLING METHOD

The sampling method used is based on drawing ambient air through a glass tube packed with charcoal, which adsorbs PERC.[1] The collected PERC is desorbed into a carbon disulfide (CS_2) solvent, which is then analyzed by gas chromatography. Determinations of PERC levels are made by relating the total PERC found in each charcoal sample to the total air volume brought into contact with the charcoal during sampling. Section 4 describes the sampling procedure in detail, and Section 5 discusses analytical measurements.

SAMPLING STRATEGY

Six laundries were chosen for this study to account for variability of laundry operations. Within each laundry, three sampling points were sampled. Four outdoor locations were sampled in the vicinity of each of the first three laundries tested; three outdoor locations were sampled in the vicinity of each of the last three laundries tested. Equipment and site acquisition difficulties reduced the number of outdoor sampling sites in the latter half of field testing.

During the study a test was performed inside an apartment directly above a laundry containing drycleaning machines. This test was conducted in the same fashion and at the same time as testing in the laundry below.

Indoor samples were collected for approximately 8 hours during normal business hours. Outdoor samples were collected for approximately 24 hours, beginning at the approximate starting time of indoor sampling at a given location.

Triplicate samples were collected at some sampling points to provide field precision data. The following scheme was used to determine triplicate samples: (1) one indoor and one outdoor point at each laundry were sampled in triplicate; (2) all indoor and all outdoor points were sampled in triplicate at two laundries; (3) one point was sampled in triplicate inside the apartments tested.

Each test period ran for seven consecutive days. The first test period (during which three laundries were tested) was August 16 to August 22, 1980; the second test period (during which the remaining three laundries were tested) was August 30 to September 5, 1980.

Sampling in a living space containing drycleaned clothing was performed following field testing. This test was performed near Cincinnati, Ohio, from October 3 through 11, 1980. During this test 24-hour sampling was performed at three points inside the room chosen, with sample flow rates approximating those used during outdoor sampling.

DISTRIBUTION OF SAMPLES

Samples were randomly distributed to PEDCo, RTI, and TRW for analysis. Section 7 presents the distribution scheme.

SECTION 4

FIELD ACTIVITIES

Field sampling in Washington, D.C., consisted of the following functions: site selection and setup, site description, routine sampling procedures, and sample storage and transport. This section describes the equipment and procedures used to perform these functions.

Equipment for charcoal tube sampling was supplied by EPA. Figure 1 shows the design of a charcoal sorption tube, a cutaway view of a sampler, and the indoor and outdoor sampler equipment. Each sampling location required the installation of one sampling unit, operating on an alternating current of 115 V. Valving to draw air flow individually from each sampling tube was installed in each sampler to eliminate the need for more than one sampling unit at each site. Polyethylene tubing (with an outside diameter of 1/4 in.) was used for vacuum lines from sample pumps to sampling points. Tygon tubing (with an inside diameter of 3/16 in.) was used to attach charcoal tubes to the sample lines. Standard NIOSH 150-mg charcoal tubes (Lot 107, manufactured by SKC, Inc.) were used for sample collection.

SITE SELECTION AND SETUP

Laundries to be tested were selected by the Consumer Product Safety Commission and EPA personnel. Outdoor sampling sites in the vicinity of each laundry were selected by PEDCo personnel. Permission was obtained from all property and business owners for access and power before the installation of sampling devices.

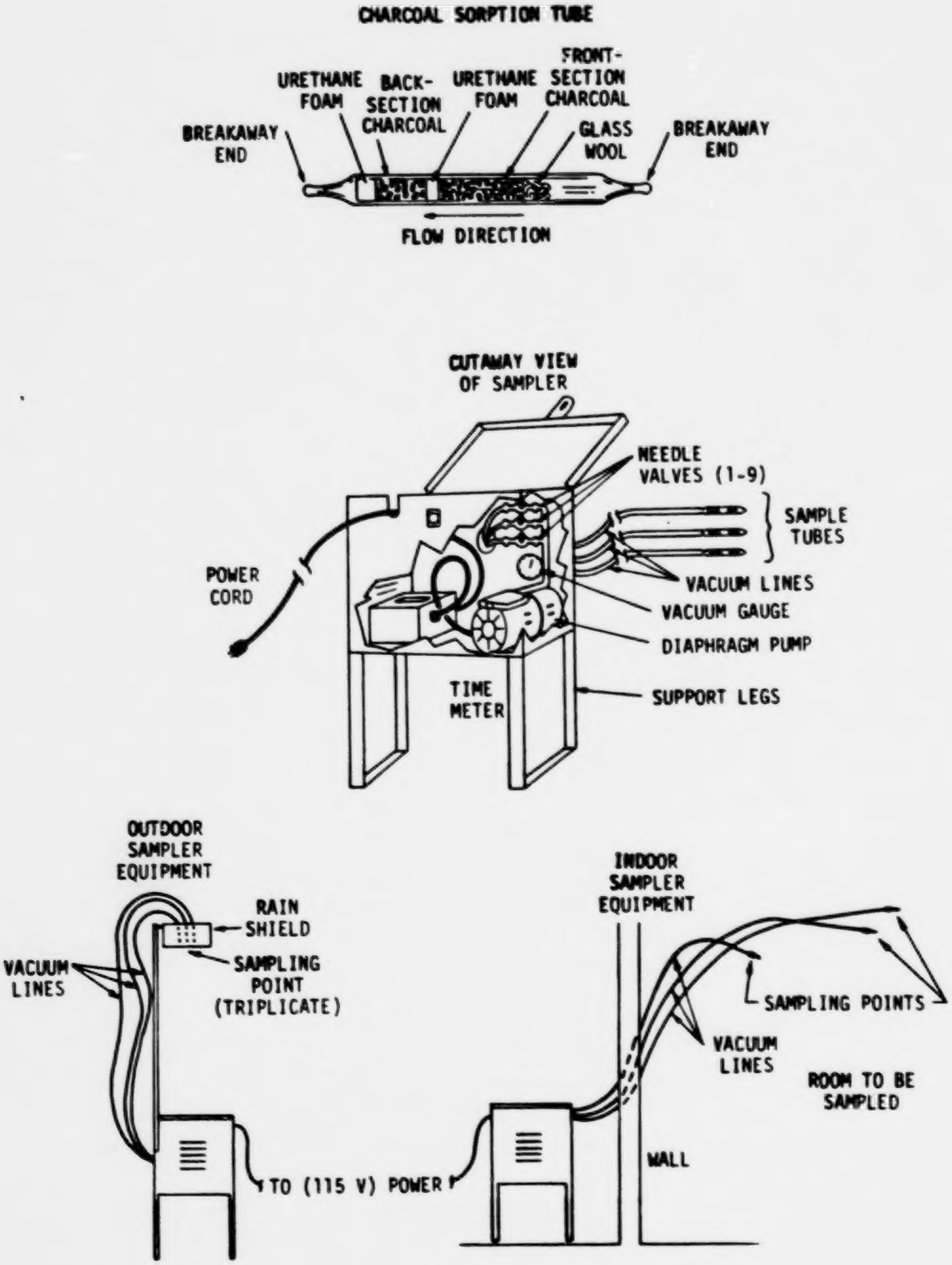

CHARCOAL SORPTION TUBE
BREAKAWAY END
URETHANE FOAM
BACK-SECTION CHARCOAL
URETHANE FOAM
FRONT-SECTION CHARCOAL
GLASS WOOL
BREAKAWAY END
FLOW DIRECTION
CUTAWAY VIEW OF SAMPLER
NEEDLE VALVES (1-9)
SAMPLE TUBES
POWER CORD
VACUUM LINES
VACUUM GAUGE
DIAPHRAGM PUMP
TIME METER
SUPPORT LEGS
OUTDOOR SAMPLER EQUIPMENT
RAIN SHIELD
VACUUM LINES
SAMPLING POINT (TRIPLICATE)
TO (115 V) POWER
INDOOR SAMPLER EQUIPMENT
SAMPLING POINTS
VACUUM LINES
ROOM TO BE SAMPLED
WALL

Figure 1. Charcoal sorption tube sampling method.

Sampling points inside laundries were chosen to provide representative samples without interfering with laundry operations. Efforts were made to represent areas of high traffic and use, and areas of high potential exposure. Areas where indoor air circulation was obstructed by walls or appliances were avoided where possible.

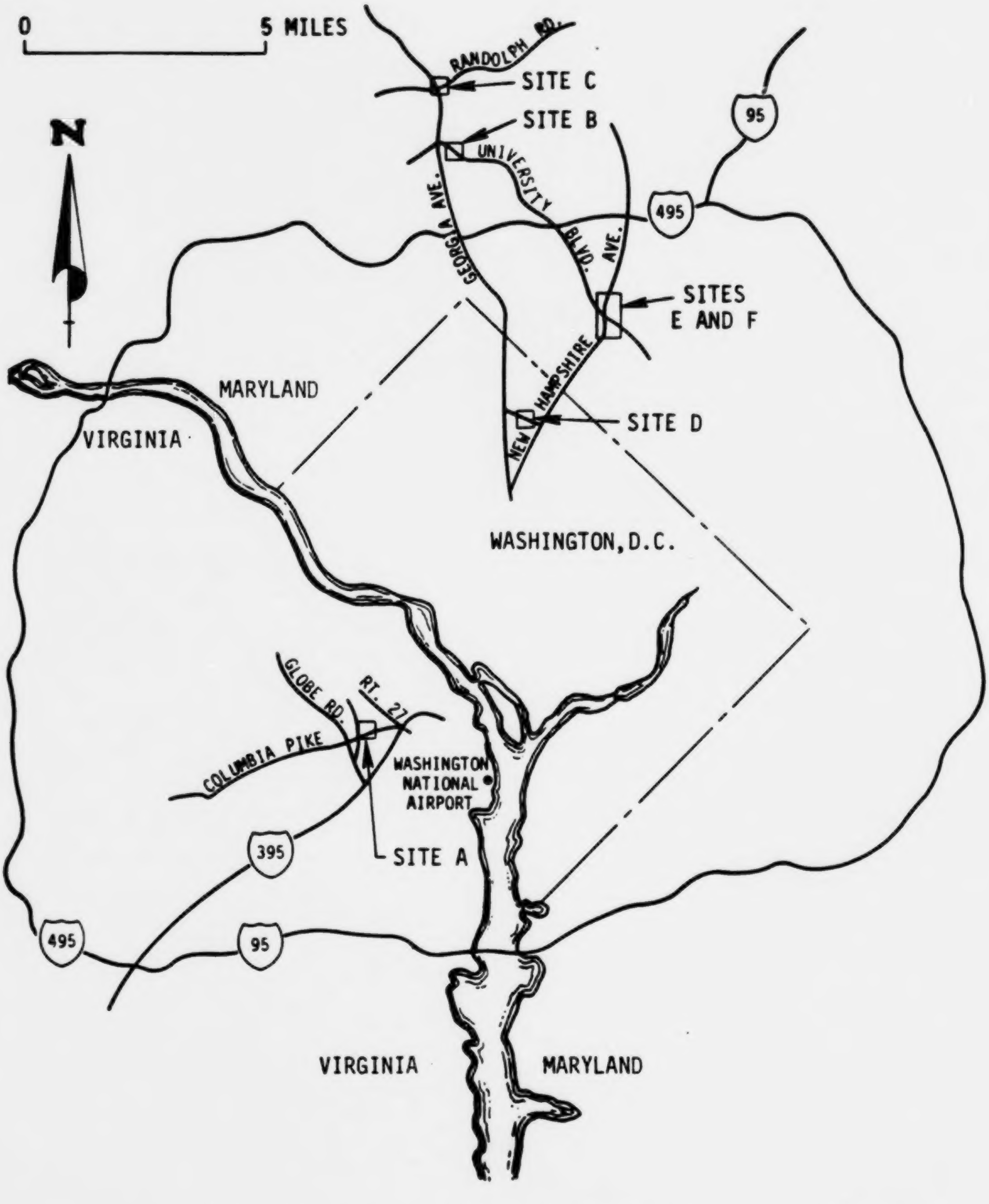
Equipment limitations allowed complete sampling at three laundries at a time. The six laundries are identified alphanumerically for the purpose of this study. The labeling scheme used is described in detail in the next subsection. Laundries A, B, and C were sampled from August 16 through 22; Laundries D, E, and F were sampled from August 30 through September 5. The period between August 22 and August 30 was used to transfer the sampling equipment from one study area to the next.

SITE DESCRIPTIONS

The locations of the laundries tested are illustrated in Figure 2. Laundry sampling was performed at a height of 6 to 7 feet above floor level. Outdoor sampling was performed at a height of 6 feet above the base of the sampler. Where outdoor sampling height as listed exceeds 6 feet, it may be presumed that the sampler was located on a rooftop or other structure.

Each site is identified by a sample code number. The code identifies the sampling site by letters "A" through "F" for laundries and "G" for the indoor clothing emission test. Following the site identification Roman numerals "I" through "V" identify specific locations. Indoor samples follow with arabic numerals "(1)," "(2)," and "(3)" to identify sampling points. Triplicate samples taken at the same sampling point were identified as "a," "b," and "c." Maps and floor plans of sampling locations are presented with the PERC data in Section 6. The individual sites were as follows:

1. Site A. Norge Village Laundry, Fillmore Gardens Shopping Center, Columbia Pike, east of Walter Reed Drive, Arlington, Virginia.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5 MILES
N
RANDOLPH RD.
SITE C
SITE B
UNIVERSITY BLVD.
GEORGIA AVE.
NEW HAMPSHIRE AVE.
95
495
SITES E AND F
SITE D
MARYLAND
VIRGINIA
WASHINGTON, D.C.
GLOBE RD.
RT. 27
COLUMBIA PIKE
WASHINGTON NATIONAL AIRPORT
SITE A
395
495
95
VIRGINIA
MARYLAND

Figure 2. Locations of sampling sites in vicinity of Washington, D.C.

A-I (indoors). This laundry is the largest of those tested and has more than 100 machines (washers, dryers, drycleaners) on the premises. Ventilation was excellent; front and back doors were open throughout testing period. Circulation of air was good because of high airflow through laundry. Use of drycleaning machines appeared to be relatively low during the tests and was possibly affected by the laundry's practice of sending clothing off the premises to a commercial drycleaner. This, however, resulted in a large amount of freshly drycleaned clothing being stored on a rack near the front of the laundry at all times.

A-II (outdoors). Private home ~700 ft northeast of laundry. The location was a residential area with single-family homes and well-wooded yards. Sampling height was 6 ft and exposure was fair.

A-III (outdoors). Restaurant ~600 ft west-southwest of laundry. The location was a commercial area adjoining a residential area. Sampling height was 20 ft and exposure was good.

A-IV (outdoors). Gas station ~200 ft south-southeast of laundry. The location was a commercial area adjoining a residential area. Sampling height was 20 ft and exposure was excellent.

A-V (outdoors). Furniture store ~600 ft east-northeast of laundry. The location was a commercial area with a shopping center. Sampling height was 25 ft and exposure was excellent.

2. Site B. Coin Laundry, Wheaton Manor Shopping Center at University Boulevard and Amherst Avenue in Wheaton, Maryland.

B-I (indoors). This laundry is the smallest of those tested and has only two drycleaning machines. Drycleaning machines were operated by an attendant and appeared to be regularly used. Ventilation and circulation were good. The front door was regularly open, and fans provided noticeable airflow.

B-II (outdoors). Veterinary office ~500 ft southeast of laundry. The location was adjacent to both residential and commercial areas. Sampling height was 20 ft and exposure was excellent.

B-III (outdoors). Gas station ~300 ft south of laundry. The location was in a diversified commercial area. Sampling height was ~20 ft and exposure was excellent.

B-IV (outdoors). Tire store ~400 ft west of laundry. The location was in a heavily commercial area. Sampling height was ~20 ft and exposure was excellent.

B-V (outdoors). Post office ~500 ft east-northeast of laundry. The location was near a medium-density residential area. Sampling height was 6 ft and exposure was good.

3. Site C. A to Z Custom Cleaners, Glenmont Norge Village, across the parking lot from Glenmont Shopping Center at the intersection of Georgia Avenue and Randolph Road in Glenmont, Maryland.

C-I (indoors). This medium-sized laundry is in a free-standing building that also contains a carryout food shop. There are eight attendant-operated drycleaning machines on the premises that were regularly used during the test. Ventilation was good during the test; the front door was open at all operating times. Air circulation was also good because the laundry had a rectangular floor plan that reduced dead-air space.

C-II (outdoors). Gas station ~200 ft east of laundry. The location was a commercial area next to a highway with high traffic volume. Sampling height was ~20 ft and exposure was excellent.

C-III (outdoors). Gas station ~150 ft west-northwest of laundry. The location was a commercial area next to a highway with high traffic volume. Sampling height was ~20 ft and exposure was excellent.

C-IV (outdoors). TV repair shop ~1100 ft northwest of laundry. The location was a commercialized area near a shopping center complex. Sampling height was ~20 ft and exposure was excellent.

C-V (outdoors). Police station ~300 ft southeast of laundry. The location bordered a residential (apartment) area and small woods. Sampling height was ~5 ft and exposure was good.

4. Site D. The Laundry Basket, Kennedy Street NE., near Missouri Avenue in Washington, D.C.

D-I (indoors). This is a neighborhood laundry of medium size. Four customer-operated drycleaning machines were on the premises and were regularly used. Ventilation was fair to good. Although the front entrance was open at all times, air circulation to the room containing the drycleaning machines was limited.

D-II (indoors). This is an apartment situated above the room in the laundry containing the drycleaning machines. The room directly above the drycleaning machines was most heavily tested; this room was not in regular use by apartment tenants during testing.

D-III (outdoors). TV repair shop ~150 ft east-southeast of laundry. The location was at the border between commercial and residential areas. Sampling height was ~20 ft and exposure was excellent.

D-IV (outdoors). Gas station ~200 ft east of laundry. The location was a commercial area in a busy intersection with residences nearby. Sampling height was ~6 ft and exposure was fair.

D-V (outdoors). Private home ~500 ft north of laundry. The location was a moderate-density residential area. Sampling height was ~6 ft and exposure was good.

5. Site E. Alkat's Sunshine Center, in a small shopping center on Holton Lane off New Hampshire Avenue in Langley Park, Maryland.

E-I (indoors). This is a medium-sized laundry with four attendant-operated drycleaning machines. The machines were in regular use during testing. Air circulation was good, but ventilation is assumed to have been poor during testing because the laundry was air-conditioned and indoor air was recirculated.

E-II (outdoors). Graphics and print shop ~250 ft east of laundry. This location bordered commercial areas on two sides and open field and wooded areas on two sides. Sampling height was ~15 ft and exposure was excellent.

E-III (outdoors). Roof of shopping center ~500 ft north-northwest of laundry. The location was surrounded by heavily commercial areas on all sides. Sampling height was ~20 ft and exposure was excellent.

E-IV (outdoors). Private home ~600 ft west-southwest of laundry. The location was a residential area with single-family homes and well-wooded yards. Sampling height was ~6 ft and exposure was good.

6. Site F. Crescent/Norge, in a shopping center immediately north of the intersection of University Boulevard and New Hampshire Avenue in Langley Park, Maryland.

   F-I (indoors). This is a medium to large laundry with eight attendant-operated drycleaning machines. Use of drycleaning machines was generally low during testing because of prescheduled machine maintenance. Ventilation was good to fair; the front entrance was open at all times. Circulation was limited, however, because the laundry had an unusual floor plan with a length to width ratio of ~5:1.

   F-II (outdoors). Gas station ~900 ft south of laundry. The location was a heavily commercial area at the intersection of two major highways. This intersection is surrounded by large shopping centers on all sides. Sampling height was ~20 ft and exposure was excellent.

   F-III (outdoors). Private home ~1000 ft northwest of laundry. The location was a residential area with single-family homes across from an apartment complex. Sampling height was ~6 ft and exposure was fair.

   F-IV (outdoors). Private home ~900 ft west-southwest of laundry. The location was a residential area with single-family homes and relatively lightly wooded yards. Sampling height was ~6 ft and exposure was good.

7. Site G. This is a room in a private home where tests were conducted to determine PERC emissions from freshly drycleaned clothing. No outdoor data were collected during this test. The home is typical of newer single-family homes and is located in a rural residential area.

ROUTINE SAMPLING PROCEDURES

Samples were collected daily at both indoor and outdoor locations. A comprehensive daily routine was followed to ensure sample quality and representativeness. This consisted of compiling complete records of time of day, sample flow rates, sampling duration, and unusual occurrences for each sample. After samples were collected, proper labeling, handling, and storage were necessary to ensure sample integrity. The procedures followed to ensure these steps are described below.

Sampling Schedules

The indoor laundry 8-hour samples were collected during the normal working day from about 9 a.m. to about 5 p.m. Actual starting and finishing times differed because sampling was manually started and ended at three laundries each day. The actual start and finish times were recorded. Each outdoor sample was collected for ~24 hours; outdoor sampling started daily at approximately the same time as indoor sampling was begun. Running time-meter readings were recorded at the beginning and end of each sampling period to account for possible interruptions in power supply.

Daily Procedures

Routine procedures were followed daily to ensure that all technical duties were performed and that thorough documentation was achieved. The specific tasks involved are described in detail below. Figure 1, which illustrates the equipment involved, may be consulted to clarify the procedures.

Each sampling location was visited in the morning at approximately 9:00 a.m. One operator attended to the following duties at indoor locations:

1. The tips of the charcoal tubes were broken to allow air to be drawn through. The tubes were then inserted into the ends of the vacuum lines at all sampling points.
2. The initial reading on the sampler time meter was recorded. The sampler was plugged in, and the vacuum gauge was checked to ensure an excess vacuum of approximately 20 in. Hg.
3. A calibrated rotameter (with a span of 140 ml/min) was attached in line to each vacuum line individually, and sampling flow rates were set to 60 ml/min by adjustment of needle valve settings.

4. Exact rotameter readings and the 24-hour starting time were recorded.

5. Observations and comments were recorded. The sampler was doublechecked to ensure that it was operating properly.

During the above procedures, outdoor sampling locations in the vicinity of the laundry were visited by another operator to collect previous 24-hour samples and begin new sampling periods. The following duties were performed at each site:

1. A calibrated rotameter (with a span of 500 ml/min) was attached to the end of each sample tube placed the previous day. Individual flow measurements were recorded.

2. Running time-meter readings and the 24-hour time were recorded. The pump vacuum was checked to ensure an excess vacuum of approximately 20 in. Hg.

3. Each sample was removed, labeled, and sealed with plastic end caps.

4. Observations and comments pertaining to collected samples were recorded.

5. The tips of fresh charcoal tubes were broken, and the tubes were then inserted into the ends of vacuum lines.

6. Running time-meter readings and the 24-hour time were recorded. The pump vacuum gauge was doublechecked for adequate excess vacuum (~20 in. Hg).

7. The rotameter was connected to the end of each tube, and individual sample flow rates were adjusted to ~230 ml/min.

8. Observations and comments pertaining to samples just begun were recorded.

Each indoor sampling site was visited approximately 8 hours after sampling was begun. The following procedures were followed:

1. Sample flow rates were checked and recorded for each charcoal tube in place with the sampler operating.

2. The sampler was checked for adequate pump vacuum (~20 in. Hg) and was then turned off.

3. The final running time-meter reading and 24-hour time were recorded.

4. Sample tubes were removed, labeled, and sealed with plastic end caps.

5. Observations and comments were recorded.

Rotometer Calibrations

Field sample flow rate measurements were made by using 150 mm scale rotometers. Each rotometer had a calibration curve prepared for it prior to use in the field, by using a bubblemeter of known volume displacement. The following two 150-mm rotometers were found to show agreement ±2 percent throughout the calibration curve prepared for each:

(1) High flow (outdoor use) ~430 ml/m Brooks^R SN 7912H43514/6
(2) Low flow (indoor use) ~120 ml/m Brooks^R SN 7912H44514/11

Sample Storage and Transport

Collected samples were placed in refrigerated storage as quickly as possible, and kept at 0°C until ready for transporting. Samples were placed in insulated containers containing a frozen ice substitute for transporting. All samples were hand-carried by air to Cincinnati. Upon arrival in Cincinnati, samples were transferred to refrigeration immediately.

SECTION 5

ANALYTICAL MEASUREMENTS

Desorption and analysis of charcoal cartridge samples were performed by PEDCo, TRW, and RTI, according to the distribution scheme presented in Section 7. Samples were desorbed in solvents containing carbon disulfide and analyzed by gas chromatography (GC) equipped with detection methods suitable for measuring PERC. Electron capture detection (ECD) was used by RTI and TRW and mass spectroscopy (MS) was used by PEDCo for measuring low levels of PERC. Flame ionization detection (FID) was used for measuring high levels of PERC. Total micrograms of PERC per sample were reported for the purpose of determining ambient PERC concentrations. Complete analytical procedures and examples of chromatograms by each lab are included in Appendix A.

The major differences in operating procedures between laboratories were as follows:

- Research Triangle Institute and TRW used GC/ECD for determining low concentrations of PERC, whereas PEDCo used GC/MS. This applied to all outdoor samples and to the study performed in a closed living space containing drycleaned clothing.
- Research Triangle Institute and TRW used 100 percent CS_2 for desorption of indoor samples for FID analysis, whereas PEDCo used 25 percent CS_2 in methanol (MeOH).

Tables 3 and 4 present the analytical instrument specifications used by each laboratory. The remainder of this section discusses procedures followed by each laboratory.

TABLE 3. INSTRUMENT SPECIFICATIONS FOR OUTDOOR SAMPLES

	RTI	TRW	PEDCo
Method	GC/ECD	GC/ECD	GC/MS
Instrument	PE 3920B	Varian 3700	HP 5992 quadrupole
Column	6 in. x 1/4 in. glass 0.1% SP-1000 m	6 ft x 2 mm glass 0.1% SP-1000 m 80/100 Carbopack C	6 ft x 2 mm glass 0.1% SP-1000 m 80/100 Carbopack C
Operating temperature	150°C isothermal	130°C isothermal	170°C isothermal
Carrier gas	27 ml/min 5% methane in argon	31 ml/min 5% methane in argon	20 ml/min helium

TABLE 4. INSTRUMENT SPECIFICATIONS FOR INDOOR SAMPLES

	RTI	TRW	PEDCo
Method	GC/FID	GC/FID	GC/FID
Instrument	HP 5880A	Varian 3700	PE 990
Column	20 ft x 1/8 in. SS 10% SP-1000 m 80/100 Supelcoport	20 ft x 1/8 in. SS 10% SP-1000 m 60/80 Supelcoport	6 ft x 2 mm glass 0.1% SP-1000 m 80/100 Carbopack C
Operating temperature	125°C isothermal	100°C isothermal	135°C isothermal
Carrier gas	29 ml/min helium	30 ml/min helium	30 ml/min nitrogen

ANALYSIS OF LOW-LEVEL (OUTDOOR) PERC SAMPLES BY GC/ECD AND GC/MS

Outdoor samples and the samples collected in a closed living space where drycleaned clothing was introduced contained relatively low PERC concentrations and required analysis by GC/ECD or GC/MS. Research Triangle Institute and TRW used GC/ECD for analyzing these samples; PEDCo used GC/MS.

GC/ECD Analyses by RTI

Research Triangle Institute analyzed 43 samples by GC/ECD according to the following procedures:

1. Front and back charcoal sections were combined and desorbed in 2.0 ml of 25 percent CS_2 in MeOH in a 3.0-ml vial, and agitated with NIOSH charcoal tube developer for 1 hour before analysis.

2. A Perkin Elmer 3920B gas chromatograph with ECD was used for analysis. Samples of 2.0 µl were manually injected for all analyses.

3. Five standards were used to make a daily calibration curve. The following standard concentrations of PERC (in 25 percent CS_2 in MeOH) were used: 0.6452 µg/ml, 1.290 µg/ml, 4.848 µg/ml, 6.452 µg/ml, and 16.13 µg/ml.

GC/ECD Analysis by TRW

TRW analyzed 58 samples by GC/ECD according to the following procedures:

1. Front and back charcoal sections were combined and desorbed with 1.0 ml of 25 percent CS_2 in MeOH. This was ultrasonicated for 5 minutes and then allowed to stand for at least 1 hour before analysis.

2. A Varian 3700 gas chromatograph with a Ni^{63} ECD was used for analysis. Samples of 2.0 µl were injected manually.

3. Three standards were used to make a daily calibration curve. The following standard concentrations of PERC (in 25 percent CS_2 in MeOH) were used: 0.244 µg/ml, 2.44 µg/ml, and 4.89 µg/ml.

GC/MS Analysis by PEDCo

PEDCo analyzed 174 samples by GC/MS according to the following procedures:

1. Front and back charcoal sections were combined in a 4.0-ml vial and desorbed in 1.0 ml of 25 percent CS_2 in MeOH. Samples were ultrasonicated for 5 minutes and allowed to stand at room termperature for 1 hour before analysis. The desorbing solvent contained an internal standard for GC/MS analysis.

2. A Hewlett Packard 5992 quadrupole gas chromatograph/mass spectroscope was used for analysis.

3. The internal standard included in the desorbing solvent consisted of 11.6 µg/ml of 1,4-dichlorobutane. The following standard concentrations of PERC were used to construct a calibration curve: 0.4058 µg/ml, 40.58 µg/ml, and 162.3 µg/ml.

ANALYSIS OF HIGH-LEVEL (INDOOR) PERC SAMPLES BY GC/FID

All indoor samples from laundries and from the apartment above a laundry contained relatively high PERC concentrations and were suitable for analysis by GC/FID. Each laboratory performed a number of analyses by GC/FID.

GC/FID Analyses by RTI

Research Triangle Institute analyzed 43 charcoal tube samples by GC/FID according to the following procedures:

1. Front and back charcoal sections were placed in a 3.0-ml vial and desorbed with 1.0 ml of 100 percent CS_2. Samples were agitated with NIOSH charcoal tube developer for at least 1 hour before analysis.

2. A Hewlett Packard 5880A automated gas chromatograph was used for analysis. Automatic injection of approximately 4.5 µl was applied to all samples.

3. A seven-point calibration curve was made daily. The following concentrations of PERC in 100 percent CS_2 were used: 6.194 µg/ml, 161.3 µg/ml, 619.4 µg/ml, 1,548.5 µg/ml, 3,871.2 µg/ml, 9,678 µg/ml, and 16,130 µg/ml.

GC/FID Analysis by TRW

TRW analyzed 70 charcoal tube samples by GC/FID according to the following procedures:

1. Front and back charcoal sections were desorbed with 1.0 ml of 100 percent CS_2 in a closed vial. Samples were agitated for 30 minutes before analysis.
2. A Varian 3700 gas chromatograph with an FID detector was used for analysis. Manual injections of 2.0 µl were made.
3. Three standards were used to make a daily calibration curve. The following standard concentrations of PERC in 100 percent CS_2 were used: 1630 µg/ml, 4890 µg/ml, and 8150 µg/ml.

GC/FID Analysis by PEDCo

PEDCo analyzed 172 samples by GC/FID according to the following procedures:

1. Front and back charcoal sections were combined in a 4.0-ml vial and desorbed with 1.0 ml of 25 percent CS_2 in MeOH. Samples were ultrasonicated for 5 minutes and allowed to sit at room temperature for 1 hour before analysis.
2. A Perkin Elmer 990 gas chromatograph was used for analysis. Manual injections of 2.0 µl were made for all samples. Retention tests were performed to ensure that the 1,4-dichlorobutane internal standard (used for GC/MS analyses) did not interfere with GC/FID analyses.
3. External standards of PERC in 25 percent CS_2 in MeOH were prepared to make a standard calibration curve. Midpoint standards were run at the beginning and end of each day to ensure linearity of the curve. The following standard concentrations of PERC were used: 162.3 µg/ml, 1623 µg/ml, 4057 µg/ml, and 8115 µg/ml.

CALCULATIONS

Raw PERC data were reported in micrograms of PERC per sample. Corrections for desorption efficiency and conversions to volume of PERC per volume of air were made after quality assurance calculations.

Determinations of μg PERC/sample were made as follows:

$$W_R = [(\frac{P_S}{V_I})/(F_C)] \times V_S$$

where W_R = raw data, μg
P_S = sample peak measurement (height or area)
V_I = volume injected, μl
F_C = calibration factor, area units or height per μg
V_S = volume of sample solvent, μl

Determinations of calibration factors (F_C) were made as follows:

$$F_C = (\frac{P_C}{V_I}) \div C$$

where P_C = standard peak (height or area)
V_I = volume injected, μl
C = standard concentration (μg/μl)

Corrections for desorption efficiency were made as follows:

$$W_C = W_R \times \frac{100}{DE}$$

where W_C = corrected weight, μg
W_R = raw data, μg
D_E = desorption efficiency, %

Laboratory staff calculated desorption efficiencies by using quality control spiked samples. Section 7 discusses preparation and analysis of these samples, including determination of desorption efficiencies.

Sample volumes were determined as follows:

$$S = \frac{(F_I + F_F)}{2} \times T \times \frac{1}{1000}$$

where S = sample volume, liters

F_I = initial flow rate, ml/min

F_F = final flow rate, ml/min

T = time elapsed, min

$\frac{1}{1000}$ = liters per millileter

Concentrations of PERC were then calculated as follows:

$$P = \frac{W_c}{S} \times \frac{1 \text{ mole PERC}}{165.8 \times 10^6 \text{ µg PERC}} \times \frac{24.47 \text{ liters air}}{1 \text{ mole air}} \times 10^9$$

where P = PERC concentration, ppb

The air conversion factor applies to standard conditions (i.e., 25°C and 29.92 in. Hg).

SECTION 6

RESULTS

This section presents the results of analyzing the samples collected in charcoal tubes. These results serve as the primary data base of the study and are treated as reference values for comparison with organic vapor monitoring badge data presented in Section 8.

Concentrations of PERC are presented on a volume-per-volume basis as parts per billion. Values are rounded to two significant figures in all cases for final reporting purposes. Mean values are reported for all cases where triplicate sampling was performed. Appendix B presents calculations and lists of ambient PERC concentration data.

Results are not available for some cases because of equipment failure during testing. Also, results are not shown for cases in which the condition of the sample or an apparent transcription error made the data questionable.

Replicate sample analyses suggest overall precision of data to be better than 20 percent for both indoor and outdoor samples. Data were omitted from the calculation of mean triplicate values when a single value failed the "Q" test determination of reliability and when this value differed by 20 percent from the mean of the other two values. Section 7 explains the quality assurance program and presents precision and accuracy results.

Figures 3 through 7 are maps of the outdoor sampling points used in this study, and Tables 5 through 10 present the daily outdoor PERC concentrations at these points. Figures 8 through 14 are floor plans of the laundries and the apartment tested and indicate all indoor sampling points. Tables 11 through 17

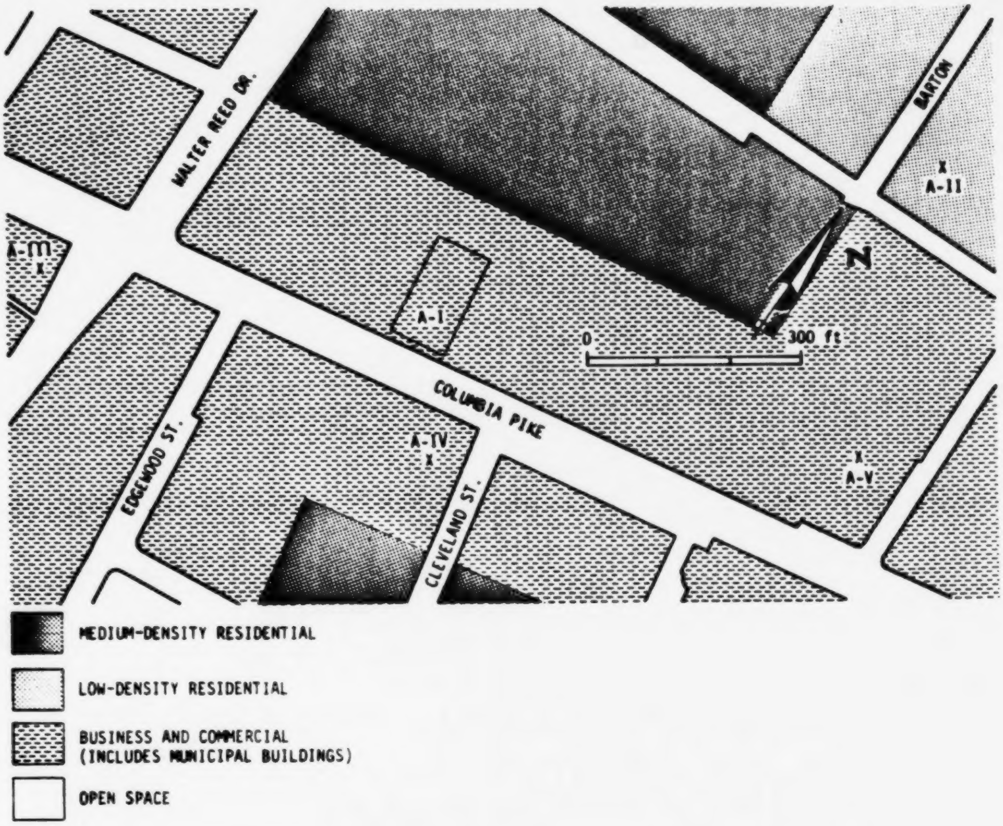

WALTER REED DR.
BARTON
A-II
A-III
A-I
N
0
300 ft
COLUMBIA PIKE
A-IV
A-V
EDGEWOOD ST.
CLEVELAND ST.
MEDIUM-DENSITY RESIDENTIAL
LOW-DENSITY RESIDENTIAL
BUSINESS AND COMMERCIAL (INCLUDES MUNICIPAL BUILDINGS)
OPEN SPACE

Figure 3. Outdoor sampling points at Site A.

TABLE 5. DAILY OUTDOOR PERC CONCENTRATIONS AT SITE A (ppb)

Sampling point	Date in 1980						
	8/16	8/17	8/18	8/19	8/20	8/22	8/23
A-II	0.14	0.20	0.72	1.5	0.84	0.93	0.49
A-III	5.3	1.9	1.7	23[a]	16[a]	5.2	8.9[a]
A-IV	b	b	b	1.2	5.2	4.3	6.3
A-V	0.12	0.47	1.6	1.2	0.43	1.4	0.57

[a] Value rechecked to ensure accuracy.

[b] Pump out.

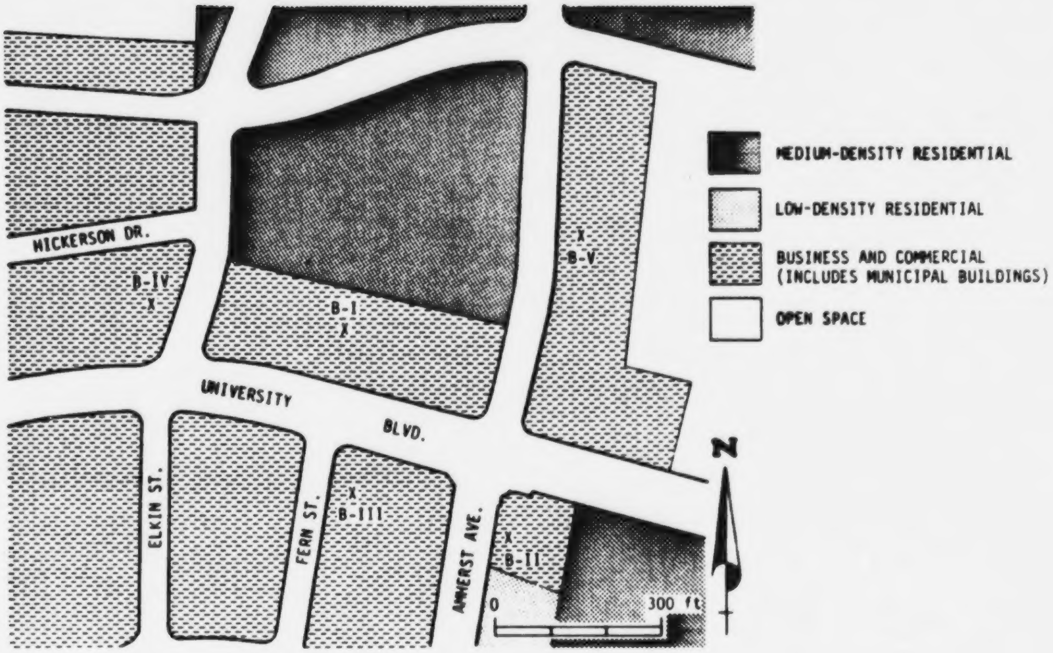

NICKERSON DR.
B-IV
B-I
B-V
UNIVERSITY
BLVD.
ELKIN ST.
FERN ST.
B-III
AMHERST AVE.
B-II
0
300 ft
N
MEDIUM-DENSITY RESIDENTIAL
LOW-DENSITY RESIDENTIAL
BUSINESS AND COMMERCIAL (INCLUDES MUNICIPAL BUILDINGS)
OPEN SPACE

Figure 4. Outdoor sampling points at Site B.

TABLE 6. DAILY OUTDOOR PERC CONCENTRATIONS AT SITE B (ppb)

Sampling point	Date in 1980						
	8/16	8/17	8/18	8/19	8/20	8/21	8/22
B-II	0.34	0.34	0.76	1.81	2.8	6.5	1.0
B-III	1.6	a	a	b	2.1	6.3	1.5
B-IV	0.30	a	2.8	0.96	0.98	1.6	0.56
B-V	0.12	a	1.3	1.9	0.39	1.1	0.48

[a] Sample waterlogged.

[b] Sample lost in analysis.

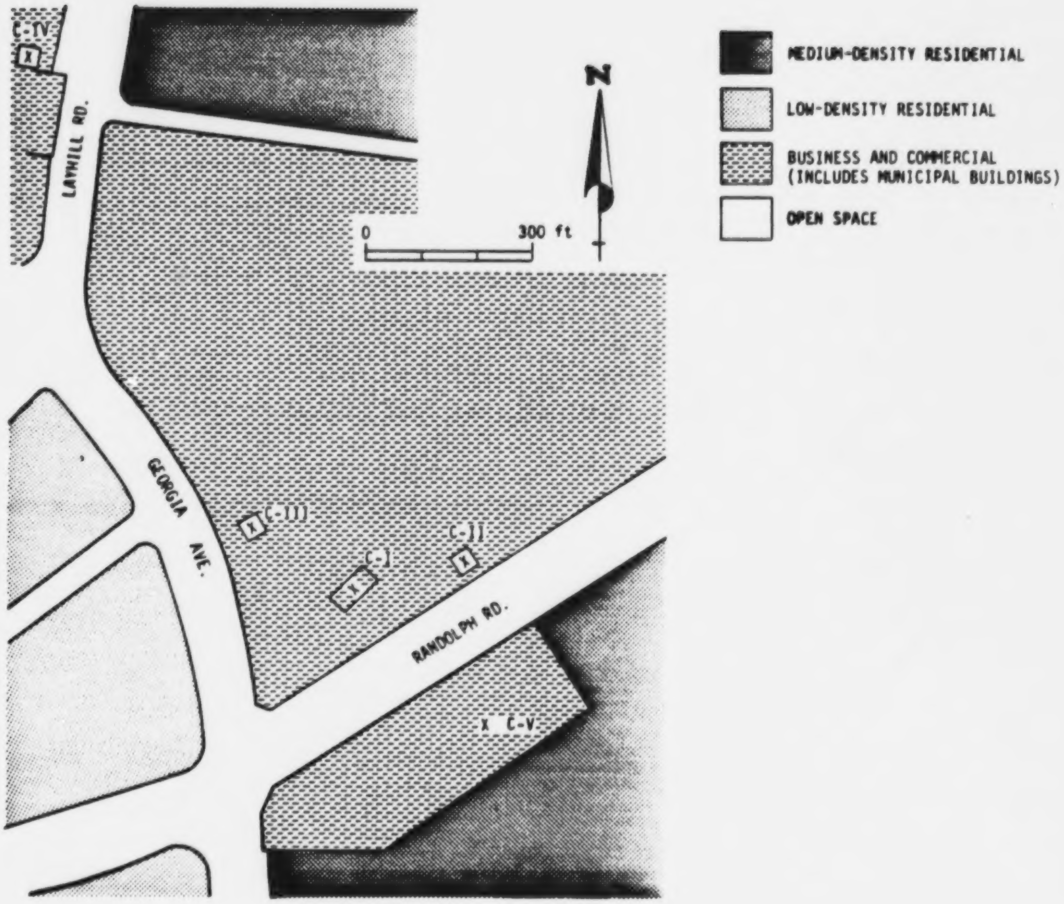

C-IV
LAYHILL RD.
GEORGIA AVE.
C-III
C-I
C-II
RANDOLPH RD.
C-V
0
300 ft
N
MEDIUM-DENSITY RESIDENTIAL
LOW-DENSITY RESIDENTIAL
BUSINESS AND COMMERCIAL (INCLUDES MUNICIPAL BUILDINGS)
OPEN SPACE

Figure 5. Outdoor sampling points at Site C.

TABLE 7. DAILY OUTDOOR PERC CONCENTRATIONS AT SITE C
(ppb)

Sampling point	Date in 1980						
	8/16	8/17	8/18	8/19	8/20	8/21	8/22
C-II	a	6.6	1.8	13	1.4	1.2	2.7
C-III	a	a	b	1.8	2.0	11	0.5
C-IV	a	a	1.5	32[c]	4.0	4.0	0.6
C-V	1.2	0.56	0.30	0.47	0.20	1.9	0.98

[a] Power off.

[b] No final sample flow.

[c] Value rechecked to ensure accuracy. Daily average for this date is suspected to be non-representative and is not included in the Summary.

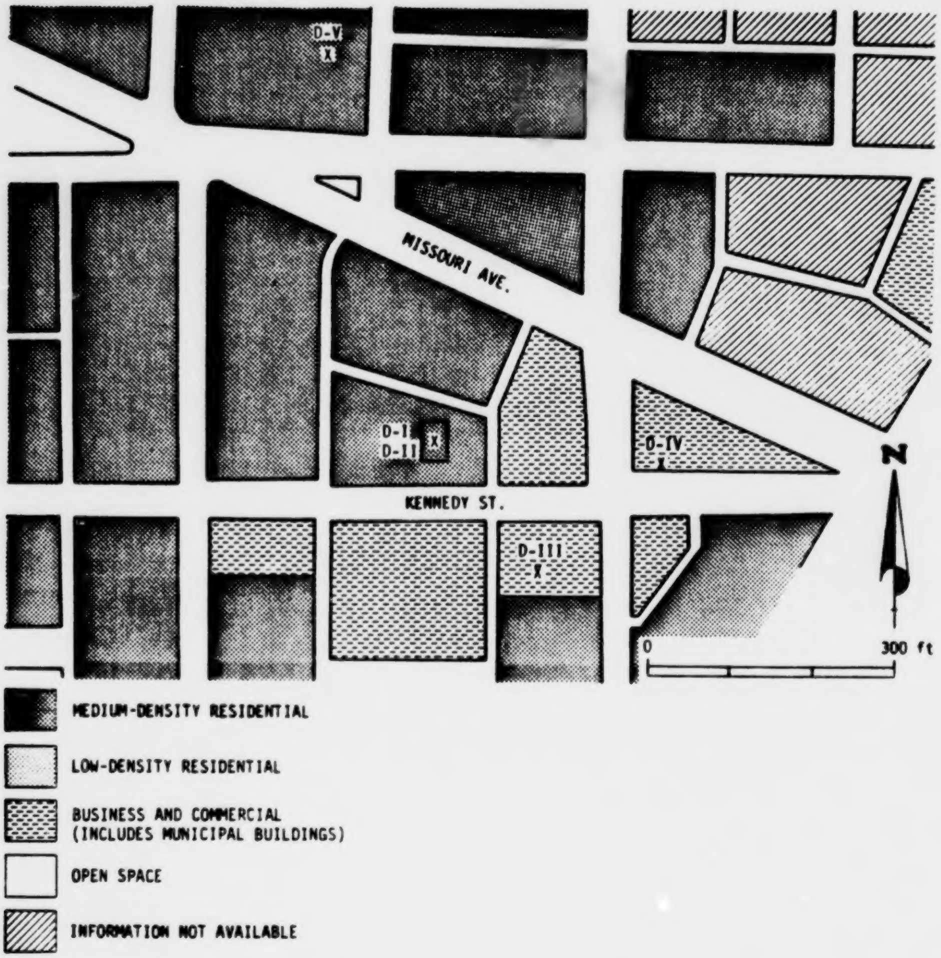

D-V
X
MISSOURI AVE.
D-I
D-II
X
D-IV
X
KENNEDY ST.
D-III
X
N
0
300 ft
MEDIUM-DENSITY RESIDENTIAL
LOW-DENSITY RESIDENTIAL
BUSINESS AND COMMERCIAL (INCLUDES MUNICIPAL BUILDINGS)
OPEN SPACE
INFORMATION NOT AVAILABLE

Figure 6. Outdoor sampling points at Site D.

TABLE 8. DAILY OUTDOOR PERC CONCENTRATIONS AT SITE D (ppb)

Sampling point	Date in 1980						
	8/30	8/31	9/1	9/2	9/3	9/4	9/5
D-III	0.84	0.52	1.7	2.7	5.1	0.58	a
D-IV	1.2	5.8	7.3	9.2	2.6	2.0	3.0
D-V	1.8	b	0.83	1.2	1.4	1.8	1.8

[a] Sample mislabeled; result void.

[b] Sample lost in analysis.

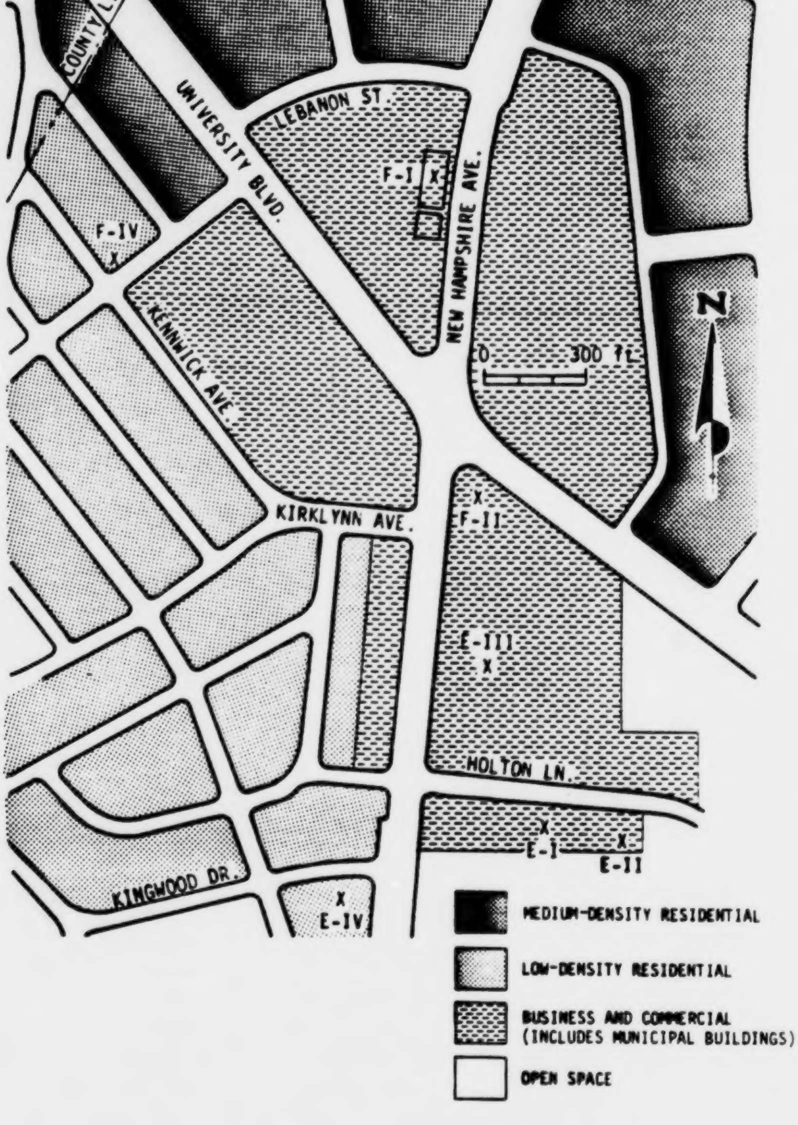

F-III
X
MERRIMAC DR.
COUNTY LINE
UNIVERSITY BLVD.
LEBANON ST.
F-I
X
NEW HAMPSHIRE AVE.
F-IV
X
KENNWICK AVE.
0
300 ft
N
KIRKLYNN AVE.
X
F-II
E-III
X
HOLTON LN.
X
E-I
X
E-II
KINGWOOD DR.
X
E-IV
MEDIUM-DENSITY RESIDENTIAL
LOW-DENSITY RESIDENTIAL
BUSINESS AND COMMERCIAL (INCLUDES MUNICIPAL BUILDINGS)
OPEN SPACE

Figure 7. Outdoor sampling points at Sites E and F.

TABLE 9. DAILY OUTDOOR PERC CONCENTRATIONS AT SITE E (ppb)

Sampling point	Date in 1980						
	8/30	8/31	9/1	9/2	9/3	9/4	9/5
E-II	a	a	a	3.6	2.6	0.67	1.2
E-III	0.50	0.05	0.32	10	3.3	1.31	b
E-IV	0.14	0.21	0.18	1.3	1.2	1.5	0.89

[a] Power off.

[b] Sample mislabeled; result void.

TABLE 10. DAILY OUTDOOR PERC CONCENTRATIONS AT SITE F (ppb)

Sampling point	Date in 1980						
	8/30	8/31	9/1	9/2	9/3	9/4	9/5
F-II	0.70	0.28	0.34	1.6	4.3	0.80	1.4
F-III	0.24	0.31	0.58	0.87	0.6	a	9.6
F-IV	0.47	0.21	0.37	0.70	3.4	10	0.87

[a] Sample lost in analysis.

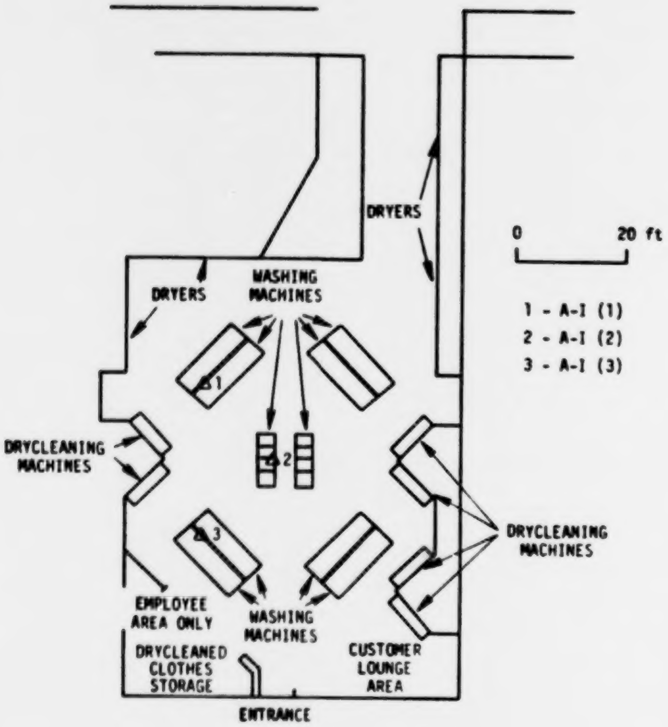

DRYERS
0
20 ft
DRYERS
WASHING MACHINES
1 - A-I (1)
2 - A-I (2)
3 - A-I (3)
1
2
DRYCLEANING MACHINES
DRYCLEANING MACHINES
3
EMPLOYEE AREA ONLY
WASHING MACHINES
DRYCLEANED CLOTHES STORAGE
CUSTOMER LOUNGE AREA
ENTRANCE

Figure 8. Indoor sampling points at Site A.

TABLE 11. DAILY INDOOR PERC CONCENTRATIONS AT SITE A (ppb)

Sampling point	Date in 1980						
	8/16	8/17	8/18	8/19	8/20	8/21	8/22
A-I (1)	89	79	140	110	110	110	230
A-I (2)	91	180	180	150	150	85	180
A-I (3)	93	40	150	130	170	110	190

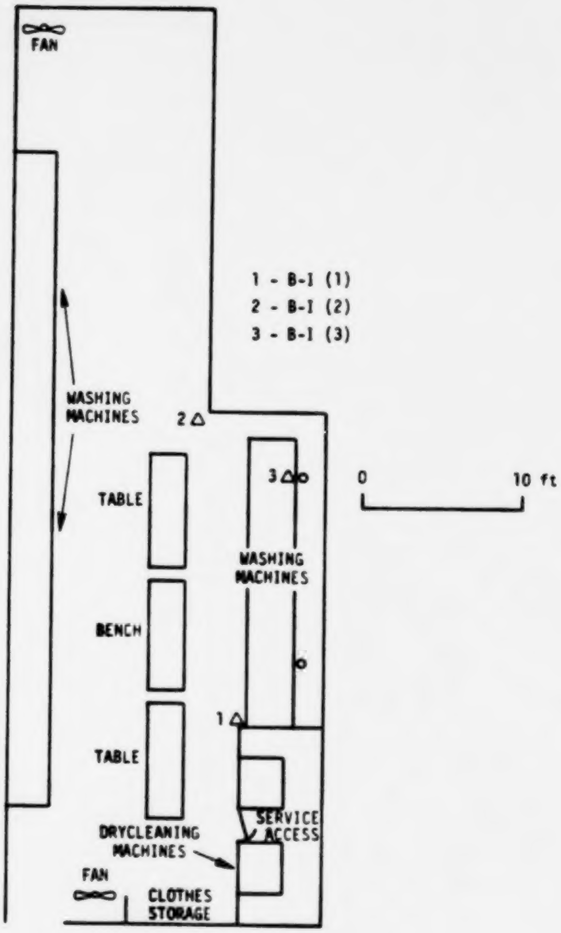

FAN
1 - B-I (1)
2 - B-I (2)
3 - B-I (3)
WASHING MACHINES
2△
3△
0
10 ft
TABLE
WASHING MACHINES
BENCH
1△
TABLE
SERVICE ACCESS
DRYCLEANING MACHINES
FAN
CLOTHES STORAGE

Figure 9. Indoor sampling points at Site B.

TABLE 12. DAILY INDOOR PERC CONCENTRATIONS AT SITE B (ppb)

Sampling point	Date in 1980						
	8/16	8/17	8/18	8/19	8/20	8/21	8/22
B-I (1)	830	170	97	260	470	310	390
B-I (2)	740	130	51	215	480	240	320
B-I (3)	540	110	77	190	a	a	260

[a] No value reported.

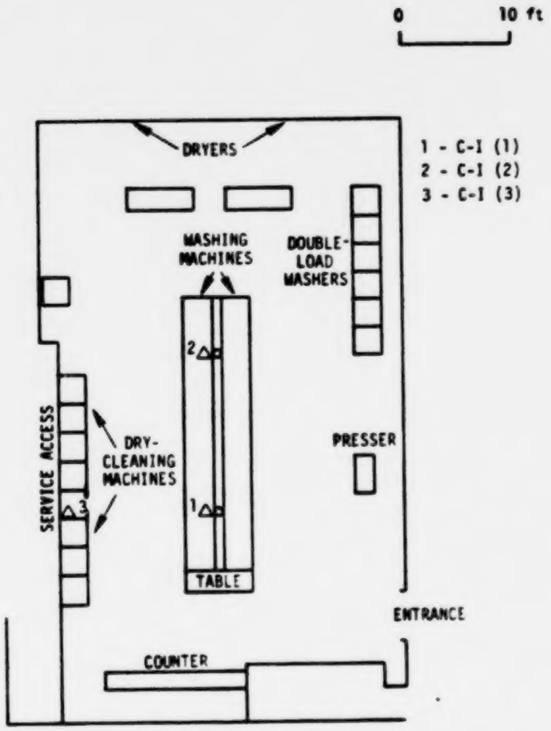

0
10 ft
DRYERS
1 - C-I (1)
2 - C-I (2)
3 - C-I (3)
WASHING MACHINES
DOUBLE-LOAD WASHERS
2
SERVICE ACCESS
DRY-CLEANING MACHINES
PRESSER
3
1
TABLE
ENTRANCE
COUNTER

Figure 10. Indoor sampling points at Site C.

TABLE 13. DAILY INDOOR PERC CONCENTRATIONS AT SITE C (ppb)

Sampling point	Date in 1980						
	8/16	8/17	8/18	8/19	8/20	8/21	8/22
C-I (1)	240	1400	3000	1600	1700	360	1400
C-I (2)	170	1500	1800	1100	1400	270	770
C-I (3)	340	2100	3300	1200	1500	390	1600

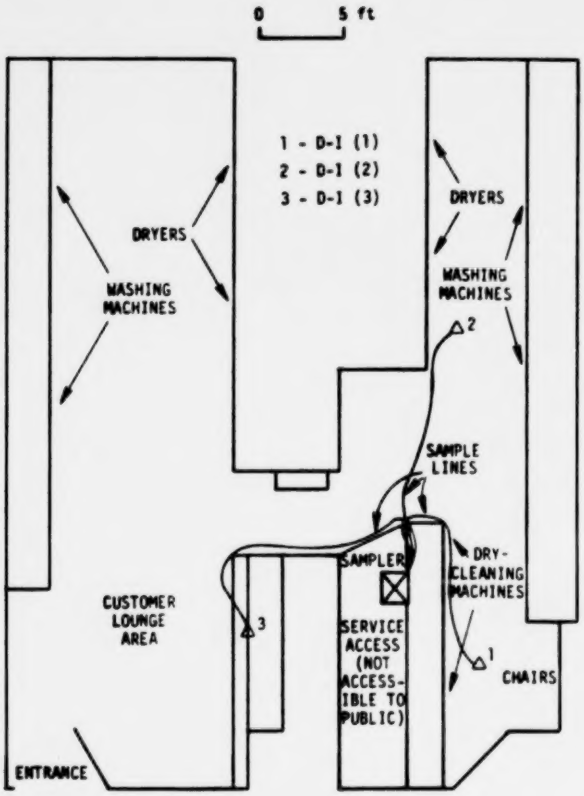

0
5 ft
1 - D-I (1)
2 - D-I (2)
3 - D-I (3)
DRYERS
WASHING MACHINES
DRYERS
WASHING MACHINES
2
SAMPLE LINES
SAMPLER
DRY-CLEANING MACHINES
CUSTOMER LOUNGE AREA
3
SERVICE ACCESS (NOT ACCESSIBLE TO PUBLIC)
1
CHAIRS
ENTRANCE

Figure 11. Indoor sampling points at Site D.

TABLE 14. DAILY INDOOR PERC CONCENTRATIONS AT SITE D
(ppb)

Sampling point	Date in 1980						
	8/30	8/31	9/1	9/2	9/3	9/4	9/5
D-I (1)	2900	1500	7600[a]	3900	1000	1900	2000
D-I (2)	200	340	3500[a]	1100	290	700	900
D-I (3)	260	b	240[a]	250	103	330	770

[a] PERC spill near machines.

[b] Sample tube broken.

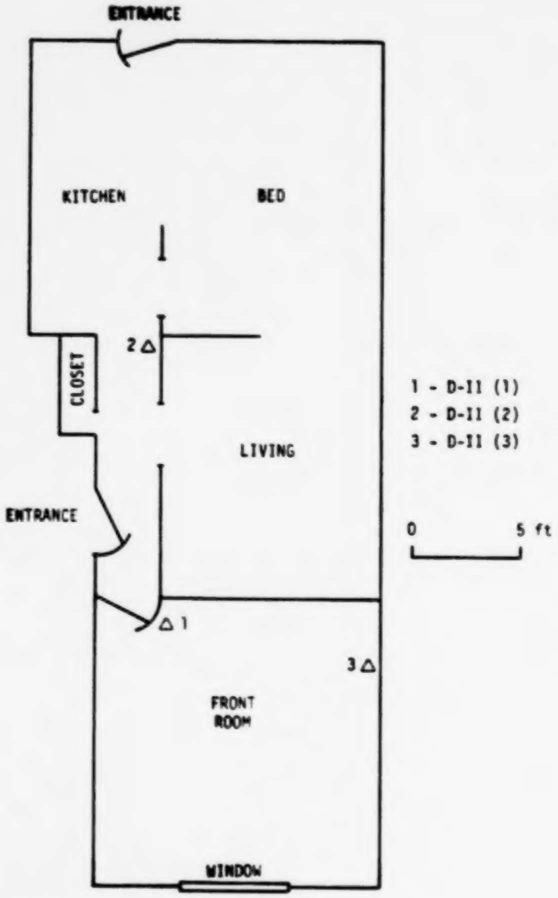

ENTRANCE
KITCHEN
BED
2
CLOSET
LIVING
ENTRANCE
1
3
FRONT ROOM
WINDOW
1 - D-II (1)
2 - D-II (2)
3 - D-II (3)
0
5 ft

Figure 12. Sampling points in apartment at Site D.

TABLE 15. DAILY PERC CONCENTRATIONS IN APARTMENT AT SITE D (ppb)

Sampling point	Date in 1980						
	8/30	8/31	9/1	9/2	9/3	9/4	9/5
D-II (1)	1100	790	3500[a]	770	3800	490	1100
D-II (2)	860	490	9700[a]	b	110	860	1000
D-II (3)	1400	770	4300[a]	670	3100	520	1400

[a] PERC spill in laundry.

[b] Sample lost in analysis.

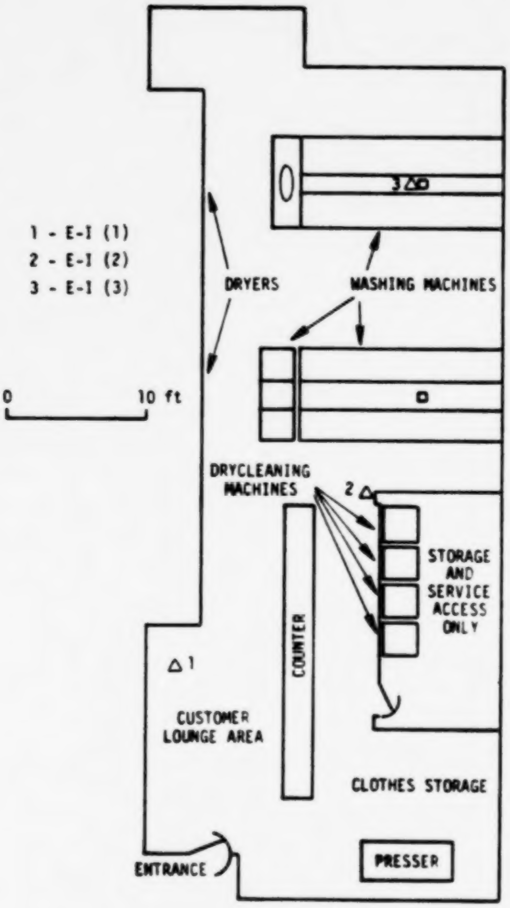

1 - E-I (1)
2 - E-I (2)
3 - E-I (3)
0
10 ft
DRYERS
WASHING MACHINES
3
DRYCLEANING MACHINES
2
STORAGE AND SERVICE ACCESS ONLY
1
COUNTER
CUSTOMER LOUNGE AREA
CLOTHES STORAGE
ENTRANCE
PRESSER

Figure 13. Indoor sampling points at Site E.

TABLE 16. DAILY INDOOR PERC CONCENTRATIONS AT SITE E (ppb)

Sampling point	Date in 1980						
	8/30	8/31	9/1	9/2	9/3	9/4	9/5
E-I (1)	14,000	7000	9,100	11,000	1600	9,100	9,600
E-I (2)	15,000	7800	10,000	9,500	2700	11,000	11,000
E-I (3)	14,000	5100	7,000	10,000	1300	7,200	6,600

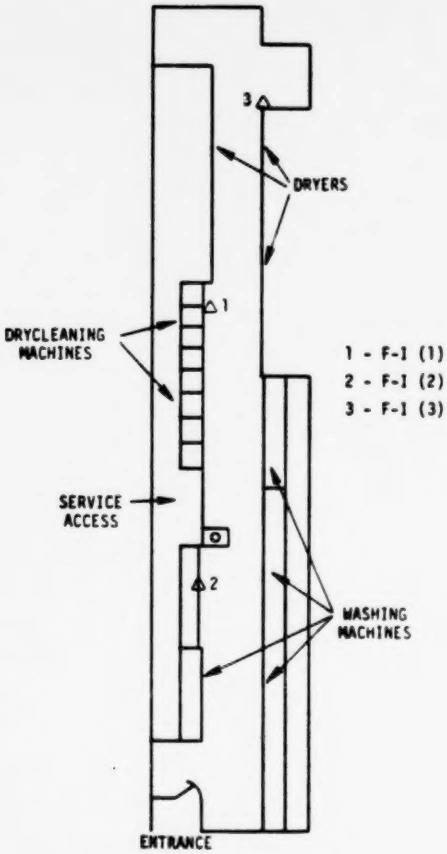

3
DRYERS
1
DRYCLEANING MACHINES
1 - F-I (1)
2 - F-I (2)
3 - F-I (3)
SERVICE ACCESS
2
WASHING MACHINES
ENTRANCE

Figure 14. Indoor sampling points at Site F.

TABLE 17. DAILY INDOOR PERC CONCENTRATIONS AT SITE F (ppb)

Sampling point	Date in 1980						
	8/30	8/31	9/1	9/2	9/3	9/4	9/5
F-I (1)	1100	810	640	360	4900	2200	1000
F-I (2)	a	320	130	100	950	900	a
F-I (3)	1000	540	570	520	3500	2300	2300

[a] No final sample flow.

present the daily indoor PERC concentrations at these points. Figure 15 is a floor plan of Site G, the closed living space where drycleaned clothing was introduced to determine PERC emissions, and indicates the indoor sampling points. Table 18 presents the daily PERC concentrations at each sampling point in this space.

Conditions at sampling points were observed during testing. The most significant observations are as follows:

> High outdoor PERC concentrations at Sampling Point A-III from August 19 through 22 were possibly caused by local use of cleaning solvents. (The sampler was located on the roof of a restaurant scheduled to open on August 25.)
>
> Rainwater caused the loss of a number of samples on August 17.
>
> Scheduled starting dates of weekly sampling were Saturdays. On several occasions, weekend and night operators of businesses failed to receive instructions to leave the power to samplers on. Thus, sampling time was lost.
>
> High indoor PERC concentrations at Site E may have resulted from the air conditioning there. This was the only air-conditioned laundry tested.

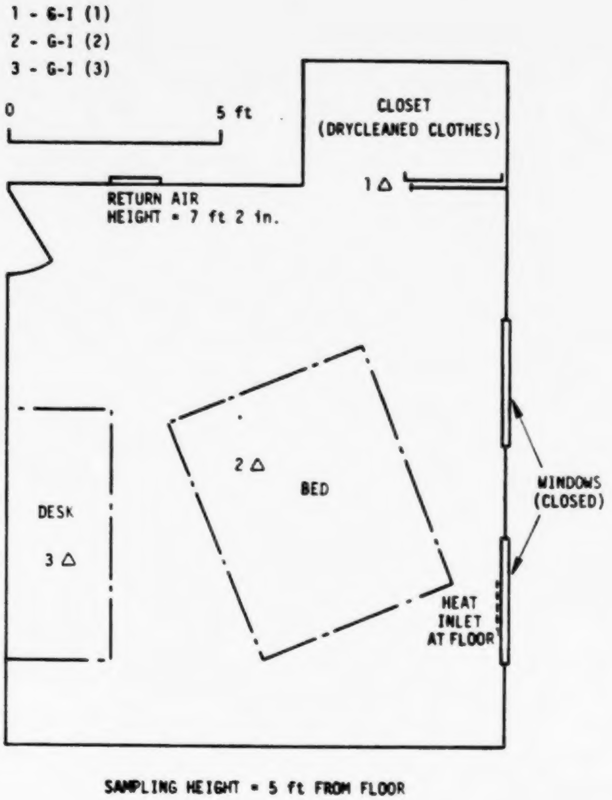

1 - G-I (1)
2 - G-I (2)
3 - G-I (3)
0
5 ft
CLOSET
(DRYCLEANED CLOTHES)
1 △
RETURN AIR
HEIGHT = 7 ft 2 in.
2 △
BED
DESK
3 △
WINDOWS
(CLOSED)
HEAT
INLET
AT FLOOR
SAMPLING HEIGHT = 5 ft FROM FLOOR

Figure 15. Sampling points at Site G, a closed living space where drycleaned clothing was introduced.

TABLE 18. DAILY PERC CONCENTRATIONS AT SITE G, A CLOSED LIVING SPACE WHERE DRYCLEANED CLOTHING WAS INTRODUCED (ppb)

Sampling point	Date in 1980								
	10/3	10/4	10/5	10/6	10/7	10/8	10/9	10/10	10/11
G-I (1)	0.17	0.18	120	18	20	22	28	11	9.6
G-I (2)	0.25	a	84	25	22	a	8.8	a	4.8
G-I (3)	b	b	103	b	9.0	28	11	16	4.2

[a] Value below detectable limit with GC/FID; all other samples at this site analyzed with EC or MS detectors.

[b] Value below detectable limit.

SECTION 7

QUALITY ASSURANCE

This section discusses the methods, calculations, and results of the extensive quality assurance (QA) program that was carried out to determine the precision and accuracy of field data. The QA program consisted of the following measures:

> Triplicate samples were collected at selected sites to determine field method precision.
>
> Samples were distributed to three laboratories to detect possible bias.
>
> External quality control spiked samples were distributed to the participating laboratories to determine accuracy of analyses.
>
> Internal quality assurance programs were carried out by each laboratory.

Duplicate analyses data were used to determine laboratory precision, and internal analyses of field replicates were used to determine total method precision.

Since sample air volume measurements were determined by separately measuring the flow rate and time duration for each sample, the precision of this parameter is based on the precision of flow and time measurements. Elapsed sampling times were recorded to the nearest minute, having a negligible effect on overall precision. Rotometers for flow measuring were calibrated to within ±2 percent of a calibration curve and did not change appreciably throughout the study. Differences from the mean flow rates of greater than 10 percent were noted on initial and final flow rates for approximately 15 percent of the samples. Precision loss due to this is assumed to be reflected in the overall method precision found by analyzing collocated samples and thus were not computed separately.

Analyses of quality control spiked samples by each laboratory provided data on total method accuracy. These data were used to determine the average desorption efficiency of PERC by each lab for each analysis method. As explained in Section 5, the desorption efficiencies obtained were used to correct all field sample data for final reporting.

Procedures for preparation of quality assurance spiked samples are presented in Appendix C. This section discusses these measures.

METHODS

Triplicate Sampling

Selected replicate samples were analyzed by PEDCo and TRW to provide data on total method precision. The remaining replicate samples were split for analysis between PEDCo, TRW, and RTI to provide data on bias between laboratories.

Sample Distribution

Samples were distributed to laboratories as shown in Table 19. This scheme was based on a plan suggested by the U.S. EPA before testing began. Sample shipment was performed by an overnight carrier using insulated containers to simulate handling conditions of field samples.

External Quality Control Spiked Samples

Research Triangle Institute worked with the U.S. EPA Environmental Monitoring Systems Laboratory QA division to coordinate distribution of spiked samples to the participating laboratories. Spiked samples were made by dynamically loading PERC vapor into charcoal cartridges taken from the same lot used for field sampling. Appendix C describes the procedures that RTI used in preparing quality control samples. Samples were then distributed

TABLE 19. DISTRIBUTION SCHEME FOR CHARCOAL TUBE FIELD SAMPLES

Sample code No.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
A-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(1)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(1)c	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(2)a	PEDCo	PEDCO	PEDCo	PEDCo	PEDCo	PEDCo	TRW
A-I-(2)b	RTI	RTI	RTI	RTI	RTI	RTI	TRW
A-I-(2)c	TRW	TRW	TRW	TRW	TRW	TRW	RTI
A-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(3)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(3)c	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-IIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
A-IIb	PEDCo	TRW	TRW	PEDCo	TRW	PEDCo	PEDCo
A-IIc	TRW	RTI	RTI	RTI	RTI	RTI	RTI
A-IIIa	PEDCo	PEDCO	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
A-IIIb	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
A-IIIc	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
A-IVa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
A-IVb	TRW	TRW	TRW	TRW	TRW	PEDCo	PEDCo
A-IVc	RTI	RTI	RTI	RTI	RTI	PEDCo	RTI
A-Va	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
A-Vb	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
A-Vc	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	RTI	PEDCo
B-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
B-I-(1)b	PEDCo	PEDCo	TRW	PEDCo	PEDCo	TRW	TRW
B-I-(1)c	PEDCo	PEDCo	RTI	PEDCo	PEDCo	RTI	TRW
B-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
B-I-(3)a	PEDCo	PEDCo	TRW	PEDCo	PEDCo	TRW	TRW
B-IIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
B-IIIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
B-IVa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
B-Va	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
B-Vb	PEDCo	PEDCO	PEDCo	PEDCo	PEDCo	TRW	TRW

(continued)

TABLE 19 (continued)

Sample code No.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
B-Vc	PEDCo	PEDCo	TRW	TRW	RTI	TRW	TRW
C-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
C-I-(1)b	TRW	TRW	TRW	TRW	TRW	PEDCo	TRW
C-I-(1)c	RTI	RTI	RTI	RTI	RTI	RTI	RTI
C-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
C-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
C-IIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
C-IIIa	PEDCo	PEDCO	PEDCo	PEDCo	PEDCo	PEDCo	TRW
C-IVa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
C-Va	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
C-Vb	PEDCo	PEDCo	TRW	TRW	TRW	TRW	PEDCo
C-Vc	RTI	RTI	RTI	RTI	RTI	RTI	RTI
D-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
D-I-(1)b	TRW	TRW	TRW	TRW	PEDCo	TRW	TRW
D-I-(1)c	RTI	RTI	RTI	RTI	RTI	RTI	RTI
D-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
D-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
D-II-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
D-II-(1)b	TRW	TRW	TRW	TRW	TRW	TRW	TRW
D-II-(1)c	RTI	RTI	RTI	RTI	RTI	RTI	RTI
D-II-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
D-II-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
D-IIIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
D-IVa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
D-IVb	TRW	TRW	TRW	TRW	TRW	PEDCo	TRW
D-IVc	RTI	RTI	RTI	RTI	RTI	RTI	RTI
D-Va	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
E-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-I-(1)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-I-(1)c	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo

(continued)

TABLE 19 (continued)

Sample code No.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
E-I-(2)b	TRW	TRW	TRW	TRW	TRW	TRW	TRW
E-I-(2)c	RTI	RTI	RTI	RTI	RTI	RTI	RTI
E-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-I-(3)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-I-(3)c	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-IIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-IIb	TRW	PEDCo	PEDCo	TRW	TRW	TRW	PEDCo
E-IIc	RTI	TRW	TRW	RTI	RTI	RTI	RTI
E-IIIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-IIIb	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-IIIc	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-IVa	PEDCo	PEDCO	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
E-IVb	TRW	TRW	PEDCo	TRW	PEDCo	PEDCo	PEDCo
E-IVc	RTI	RTI	TRW	TRW	TRW	PEDCo	PEDCo
F-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
F-I-(1)b	PEDCo	PEDCo	TRW	TRW	TRW	PEDCo	TRW
F-I-(1)c	RTI	RTI	RTI	RTI	RTI	RTI	RTI
F-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
F-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
F-IIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
F-IIb	TRW	PEDCo	TRW	PEDCo	TRW	TRW	TRW
F-IIc	RTI	RTI	RTI	RTI	RTI	RTI	RTI
F-IIIa	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
F-IV	PEDCo	PEDCO	PEDCo	PEDCo	PEDCo	PEDCo	TRW
G-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo
G-I-(2)a	PEDCo	TRW	PEDCo	RTI	RTI	TRW	PEDCo
G-I-(3)a	RTI	RTI	RTI	TRW	PEDCo	RTI	PEDCo

	Day 8	Day 9
G-I-(1)a	PEDCo	PEDCo
G-I-(2)a	TRW	PEDCo
G-I-(3)a	RTI	PEDCo

for analysis as unknowns to TRW and PEDCo, and reported values were compared with known values to determine bias. Incomplete desorption of PERC from charcoal before analysis was presumed to cause the bias determined. Thus, all field sample data were corrected for the bias determined before final reported values were calculated. Shipping of QC samples was done in the same manner that samples were distributed to laboratories.

Internal Quality Control

Each laboratory performed internal quality control testing to provide data demonstrating the precision and accuracy of analysis results. Internal quality control procedures included the preparation and use of calibration standards, duplicate analyses of samples, and random analyses of front and back charcoal sections to check PERC breakthrough.

Standards for calibration were prepared from PERC aliquots diluted to standard concentrations with CS_2 solvent. This solvent was drawn from the same lot as that used for desorption of samples and blank analysis. Multiple dilutions were made to prepare standards for multipoint calibration curves, which were used to bracket expected sample analysis readings. Standards were analyzed daily to provide time bracketing of all sample analyses.

Approximately 10 percent of all samples were randomly selected for duplicate analysis. Duplicate analyses were performed by reinjecting samples and determining the differences between PERC values for the initial and reinjected samples. Duplicate injections were scheduled randomly to account for bias resulting from daily drift, operator imprecision, and day-to-day calibration differences.

Approximately 5 percent of the charcoal tubes from indoor and outdoor sampling were randomly chosen for analyses of front and back sections to determine PERC breakthrough. Front and back sections of charcoal tubes were desorbed and analyzed separately. Confirmation of PERC in a back section demonstrates breakthrough from the front section. Values from analyses of front and back sections were combined to calculate the total PERC in charcoal tubes analyzed in this way.

CALCULATIONS

The QA program required calculation of the following:

Coefficients of variation from analyses of collocated charcoal tube samples and from duplicate and triplicate analyses of selected charcoal tube samples

Average PERC breakthroughs from analyses of front and back sections of charcoal tubes

Average recovery efficiencies within a 95 percent confidence interval from analyses of quality control spiked samples

Coefficients of Variation

The coefficients of variation were determined as follows:[2,3]

$$C.V._j = \sum_{i=1}^{n_j} Y_i / \sum_{i=1}^{n_j} X_i$$

where C.V. = coefficient for a pooled set of data sets;
n_j = number of data sets in set;
Y = standard deviation of data set;
X = mean concentration of data set.

For the above determination to be valid there must be a proportional relationship between standard deviation and concentration. Otherwise, high concentration values are likely to provide a distortion of the precision estimate by weighing the calculation value to reflect the C.V. only near the high end of the range included in the pool set. Tests demonstrating the proportional relationships for each set were made to validate the C.V. computations and are presented in the Appendix on pp. D-18 and D-19.

Average PERC Breakthrough

The PERC breakthrough in a charcoal tube was determined as follows:

$$C = [B/(F + B)]100$$

where C = PERC breakthrough, %
B = total PERC in back section of tube, μg
F = total PERC in front section of tube, μg

The average PERC breakthrough for a set of tubes was then determined as follows:

$$\overline{C} = (\sum_{i=1}^{n} C_i)/n$$

where $\overline{C}$ = average PERC breakthrough, %
n = number of tubes in set
C_i = PERC breakthrough of the i^{th} tube, %

Average Recovery Efficiency Within a 95 Percent Confidence Interval

The recovery efficiency for a sample was determined as follows:

$$RE = (V_R/V_E)100$$

where RE = recovery efficiency, %
V_R = value reported
V_E = value expected

The average recovery efficiency for a set of samples was then determined as follows:

$$\overline{RE} = (\sum_{i=1}^{n} RE_i)/n$$

where $\overline{RE}$ = average recovery efficiency, %

n = number of samples in set

RE_i = recovery efficiency for the i^{th} sample, %

The 95 percent confidence interval for an average recovery efficiency was calculated as follows:

$$CI_{95} = [t_{0.975}/(n\sqrt{n-1})] \sqrt{n \sum_{i=1}^{n} (RE_i^2) - (\sum_{i=1}^{n} RE_i)^2}$$

where CI_{95} = 95 percent confidence interval

n = number of samples in set

$t_{0.975}$ = a value dependent on the value of n

The following list of $t_{0.975}$ values was used in calculating 95 percent confidence intervals:

n	$t_{0.975}$	n	$t_{0.975}$	n	$t_{0.975}$
2	12.706	7	2.447	12	2.201
3	4.303	8	2.365	13	2.179
4	3.182	9	2.306	14	2.160
5	2.776	10	2.262	15	2.145
6	2.571	11	2.228	16	2.131

The values shown are corrected for (n-1) degrees of freedom.

RESULTS

Table 20 presents coefficients of variation that were determined by analyses of collocated indoor and outdoor charcoal tube samples. The QA program included analyses by PEDCo and TRW. Interlaboratory analyses to determine interlaboratory precision of collocated samples were not performed since interlaboratory error was separately determined using spiked QC tubes. As indicated, the total method precision of PEDCo and TRW estimates was approximately 20 percent for both indoor and outdoor samples. The values shown are based on data in Appendix D.

TABLE 20. TOTAL METHOD PRECISION DETERMINED BY ANALYSES OF COLLOCATED CHARCOAL TUBE FIELD SAMPLES

Laboratory	Coefficient of variation of indoor samples, %	N[a]	Coefficient of variation of outdoor samples, %	N[a]
PEDCo	19.0[b]	32	18.1[c]	38
TRW	13.7[b]	7	24.9[d]	5
RTI	(No analyses)		(No analyses)	

[a] N = number of replicate sets included in each determination.

[b] GC/FID.

[c] GC/MS.

[d] GC/ECD.

Table 21 presents coefficients of variation determined by duplicate and triplicate analyses of selected charcoal tube samples. The QA program included analyses by PEDCo, TRW, and RTI, but did not involve interlaboratory analyses of identical samples. As indicated, the method precision of all three laboratories averaged less than 3 percent for indoor samples and less than 4 percent for outdoor samples. The values shown are based on data in Appendix D.

TABLE 21. LABORATORY METHOD PRECISION DETERMINED BY DUPLICATE AND TRIPLICATE ANALYSES OF SELECTED CHARCOAL TUBE SAMPLES

Laboratory	Coefficient of variation of indoor samples, %	N[a]	Coefficient of variation of outdoor samples, %	N[a]
PEDCo	1.3[b]	26	2.6[c]	13
TRW	2.2[b]	5	1.3[d]	4
RTI	2.1[b]	10	3.9[d]	6

[a] N = number of replicate sets included in each determination.

[b] Duplicate analyses performed using GC/FID.

[c] Duplicate analyses performed using GC/MS.

[d] Triplicate analyses performed using GC/ECD.

Table 22 presents average PERC breakthroughs determined by analyses of front and back sections of charcoal tubes. The QA program included analyses by PEDCo and TRW. As indicated, average PERC breakthrough was less than 2 percent for indoor samples, but higher for outdoor samples. The 21.4 percent breakthrough reported by TRW represents only one outdoor sample and should not be considered proof of a trend. The values shown are based on data in Appendix D.

Table 23 represents average recovery efficiencies within a 95 percent confidence interval determined by analyses of quality control spiked samples. The QA program included analyses by PEDCo, TRW, and RTI. As indicated, average recovery efficiencies varied from 86.4 to 98.5 percent for indoor samples and from 60.1 to 84.6 percent for outdoor samples. Different desorption methods probably account for the different efficiencies. The values shown are based on data in Appendix E.

TABLE 22. AVERAGE PERC BREAKTHROUGHS DETERMINED BY ANALYSES OF FRONT AND BACK SECTIONS OF CHARCOAL TUBES (%)

Laboratory	Indoor samples	Outdoor samples
PEDCo	0.39	5.74
TRW	1.48	21.40[a]
RTI	(No analyses)	(No analyses)

[a] Only one value reported.

TABLE 23. AVERAGE RECOVERY EFFICIENCIES WITHIN A 95 PERCENT CONFIDENCE INTERVAL DETERMINED BY ANALYSES (%)

Laboratory	Indoor samples	Outdoor samples
PEDCo	86.4 ± 10.2	84.6 ± 8.9
TRW	98.5 ± 2.9	67.8 ± 5.5
RTI	88.1 ± 4.6	60.1 ± 1.9

Within most of the individual pooled data sets used to arrive at precision estimates, wide ranges of concentrations are found. Trends were found that suggest that precision errors are proportional according to the levels found. This was determined by performing linear regressions comparing standard deviations to concentrations for individual data sets within each pooled data set. Table D-19 in Appendix D of this report presents these findings.

SECTION 8

EVALUATION OF ORGANIC MONITORING BADGES

At two laundries, PERC concentrations were measured by organic monitoring badges at the same time as they were measured by charcoal tubes. The charcoal tube results (discussed in the previous section) were used to check the accuracy of the badges, which were supplied by Minnesota Mining & Manufacturing (3M) and by E.I. Du Pont de Nemours & Co.

SAMPLE PROTOCOL

Sampling Method

Like charcoal tube sampling, badge monitoring is based on the adsorption of organic molecules on charcoal collection surfaces, which are later desorbed for analysis by gas chromatography. Both badge methods rely on gas diffusion rates through controlled surfaces to supply air volume data. A 3M badge has a porous membrane, and a Du Pont badge has multiple short tubes. Manufacturer information indicated that air flow sampling rates (i.e., PERC diffusion rates) were 28.9 ml/min for the 3M badge and 70.8 ml/min for the Du Pont badge.

Sampling Strategy

Two laundries (A and E) were chosen for testing with badges. These sites were monitored in triplicate with 3M and Du Pont badges at each indoor sampling point. Each sampling point was also monitored in triplicate with charcoal tubes during each test. Daily tests lasting ~8 hours were conducted for 7 days at each laundry.

Distribution of Samples

Samples were distributed to PEDCo, RTI, and TRW laboratories for analysis as shown in Tables 24 and 25. This distribution scheme was designed to divide samples randomly among laboratories as part of the quality assurance program.

FIELD ACTIVITIES

Sampling Equipment

The badges used consisted of small plastic containers designed to clip onto clothing. The badges contained charcoal strips that adsorbed organic vapors for later analysis.

Site Selection and Setup

The EPA Project Officer selected the two laundries at which badges were tested from the six laundries involved in this project. Equipment and preliminary preparation needed were minimal, because badges were readily attachable to sampling points.

Site Descriptions

The laundries tested with badges are described in Section 4 as Site A and Site E.

Routine Sampling Procedures

The sampling schedule described in Section 4 for charcoal tube sampling at Laundries A and E applies to badge sampling. The tasks specified for badges are outlined below:

1. Initial and final times were recorded to within 5 minutes.
2. Badges were clipped to sample vacuum lines or other projections to ensure that air circulation to diffusion surfaces was not impaired, that badges were within 12 in. of charcoal tubes, and that badges did not interfere with air flow to charcoal tubes.
3. Badges were kept sealed before use and resealed immediately after use, per manufacturer instructions.

TABLE 24. DISTRIBUTION OF 3M BADGES FOR ANALYSIS

Sample code No.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
A-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(1)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(1)c	TRW	PEDCo	RTI	PEDCo	RTI	PEDCo	PEDCo
A-I-(2)a	PEDCo	PEDCO	PEDCo	PEDCo	PEDCo	TRW	PEDCo
A-I-(2)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	PEDCo
A-I-(2)c	TRW	TRW	TRW	TRW	TRW	RTI	TRW
A-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(3)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(3)c	TRW	TRW	RTI	TRW	PEDCo	RTI	TRW
E-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
E-I-(1)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
E-I-(1)c	PEDCo	RTI	TRW	TRW	TRW	PEDCo	TRW
E-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
E-I-(2)b	PEDCo	RTI	TRW	PEDCo	PEDCo	PEDCo	TRW
E-I-(2)c	RTI	RTI	TRW	PEDCo	PEDCo	PEDCo	TRW
E-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
E-I-(3)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW
E-I-(3)c	TRW	PEDCo	TRW	TRW	TRW	RTI	TRW

TABLE 25. DISTRIBUTION OF DU PONT BADGES FOR ANALYSIS

Sample code No.	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
A-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(1)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(1)c	RTI	PEDCo	RTI	RTI	TRW	TRW	RTI
A-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(2)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(2)c	TRW	TRW	PEDCo	TRW	RTI	TRW	TRW
A-I-(3)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(3)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
A-I-(3)c	TRW	RTI	TRW	TRW	TRW	RTI	TRW
E-I-(1)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
E-I-(1)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
E-I-(1)c	TRW	RTI	PEDCo	TRW	TRW	PEDCo	PEDCo
E-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
E-I-(2)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
E-I-(2)c	TRW	TRW	TRW	TRW	RTI	TRW	PEDCo
E-I-(2)a	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
E-I-(3)b	PEDCo	PEDCo	PEDCo	PEDCo	PEDCo	TRW	TRW
E-I-(3)c	TRW	PEDCo	TRW	TRW	TRW	TRW	PEDCo

4. Samples were labeled immediately upon collection to identify location and date.

5. Wet- and dry-bulb temperatures were recorded for later reference, although both manufacturers stated in user instructions that only extreme humidity or temperature conditions significantly affect operation.

Sample Storage and Transport

Samples were stored at 0°C until transport to the PEDCo laboratory for distribution and analysis. Samples were hand-carried from the field by air in insulated containers.

ANALYTICAL MEASUREMENTS

Desorption and analysis of badge samples were performed by PEDCo, TRW, and RTI, according to the distribution scheme presented in Tables 24 and 25. Analytical procedures were essentially the same as those presented in Section 5 for charcoal tube analyses by GC/FID. The only differences were the methods used to desorb the samples.

The two types of badges required unique desorption techniques because of their physical characteristics. The 3M badges required desorption with 1.5 ml of desorbing solvent instead of 1.0 ml, as used with charcoal tubes. Desorption was performed inside the badge itself, which is designed for this purpose. According to the manufacturer instructions, the sample was transferred after desorption to a sealed vial for analysis by GC/FID.

The Du Pont badges required desorption in a fashion similar to that used for charcoal tubes. The entire charcoal adsorption medium was transferred to a vial and desorbed according to manufacturer instructions. The sample was then analyzed by GC/FID.

Calculations were performed as described in Section 5. Information from 3M and Du Pont on diffusion rates was used to determine sample volumes.

RESULTS

Tables 26 and 27 show daily indoor PERC concentrations determined by badge and charcoal tube sampling at Laundries A and E, and Table 28 shows average PERC concentrations. Appendix B lists badge data.

As indicated by Table 28, the differences between values determined by 3M badges and charcoal tubes ranged from -49.8 to +16.7 percent, and the average difference was -25.3 percent. The differences between values determined by Du Pont badges and charcoal tubes ranged from -33.3 to -50.9 percent, and the average difference was -42.0 percent. These discrepancies deserve careful attention and indicate the experimental status of organic monitoring badges.

Badge monitoring is a relatively new development. Diffusion rates for different compounds must be determined to calculate the effective sample air volume contact. Also, the recovery efficiency of each compound must be determined to establish whether a correction is necessary. These two factors can vary considerably from compound to compound and affect the results obtained with both types of badges used in this study.

Recent work by Du Pont suggests that the factors originally supplied for PERC sampling are possibly in error. Because the results of this work were not confirmed during the performance of analyses, the factors previously supplied by Du Pont were used. No revised information has been received about factors used for the 3M badges.

QUALITY ASSURANCE

The QA program consisted of laboratory (internal quality control) procedures, as described in Section 5, and analyses of spiked badge samples similar to the analyses of spiked charcoal

TABLE 26. DAILY INDOOR PERC CONCENTRATIONS DETERMINED BY ORGANIC MONITORING BADGES AND CHARCOAL TUBES AT SITE A
(ppb)

	Sampling point	Date in 1980						
		8/16	8/17	8/18	8/19	8/20	8/21	8/22
3M badge	A-I (1)	30	38	78	48	91	340	230
Du Pont badge	A-I (1)	72	47	88	70	100	70	130
Charcoal tube	A-I (1)	89	79	140	110	110	110	230
3M badge	A-I (2)	93	140	110	64	27	250	71
Du Pont badge	A-I (2)	36	86	95	83	91	64	100
Charcoal tube	A-I (2)	91	180	180	150	150	85	180
3M badge	A-I (3)	51	16	86	160	95	230	380
Du pont badge	A-I (3)	50	40	120	94	99	53	130
Charcoal tube	A-I (3)	93	40	150	130	170	110	190

TABLE 27. DAILY INDOOR PERC CONCENTRATIONS DETERMINED BY ORGANIC MONITORING BADGES AND CHARCOAL TUBES AT SITE E
(ppb)

	Sampling point	Date in 1980						
		8/30	8/31	9/1	9/2	9/3	9/4	9/5
3M badge	E-I (1)	6,700	4100	5,100	5,700	900	5,400	7,300
Du Pont badge	E-I (1)	5,300	3600	4,200	4,800	800	6,700	8,700
Charcoal tube	E-I (1)	14,000	7000	9,100	11,000	1600	9,100	9,600
3M badge	E-I (2)	6,800	3800	5,900	6,200	1400	4,700	6,400
Du Pont badge	E-I (2)	6,000	3900	6,300	6,800	1600	7,800	5,100
Charcoal tube	E-I (2)	15,000	7800	10,000	9,500	2700	11,000	11,000
3M badge	E-I (3)	4,600	2700	1,800	5,500	890	5,200	5,000
Du Pont badge	E-I (3)	5,200	2200	3,100	3,900	870	5,400	4,400
Charcoal tube	E-I (3)	14,000	5100	7,000	10,000	1300	7,200	6,600

TABLE 28. AVERAGE PERC CONCENTRATIONS DETERMINED BY ORGANIC MONITORING BADGES AND CHARCOAL TUBES[a]

(ppb except as indicated)

Location	Charcoal tube	3M badge	Difference between charcoal tube and 3M badge, %	Du Pont badge	Difference between charcoal tube and Du Pont badge, %
A-I (1)	124	121	-2.4	82.1	-33.8
A-I (2)	145	107	-26.2	79.5	-45.2
A-I (3)	126	147	+16.7	84.0	-33.3
E-I (1)	8771	5037	-42.6	4877	-44.4
E-I (2)	9571	5039	-47.4	5343	-44.2
E-I (3)	7314	3675	-49.8	3588	-50.9

[a] Site A averages cover August 16 through 22, 1980. Site E averages cover August 30 through September 5, 1980. Percentage differences between values determined by organic monitoring badges and charcoal tubes were calculated as follows:

[(badge value - tube value)/tube value]100 tube samples described in Section 7. Although discrepancies were found between PERC concentrations determined to be loaded on spiked badge samples and PERC concentrations reported by laboratories, the laboratory values were not used to determine desorption efficiencies. Instead, desorption efficiencies based on available information from manufacturers were used. Appendix C discusses the preparation method for spiked badge samples.

Table 29 presents coefficients of variation (C.V.) determined by analyses of collocated badge samples. The QA program included analyses by PEDCo and TRW, but did not involve interlaboratory analyses of collocated samples. As indicated, total method precision is somewhat better for Du Pont badges than 3M badges and for Site E than Site A. Air conditioning and higher PERC concentrations may have enhanced the reproducibility of badge data from Site E. The values shown are based on data in Appendix D.

The average recovery efficiencies within a 95 percent confidence interval determined by analyses of quality control spiked badge samples are as follows:

Laboratory	Average recovery efficiency, %
PEDCo	27.8 ± 8.7
TRW	43.3 ± 5.4
RTI	35.6 ± 2.4

The values shown are based on data in Appendix E. As indicated, recovery efficiencies were substantially less than 100 percent. Information in Table 28 suggests an analytical error of some nature if charcoal tube concentrations are considered reference values. The even greater discrepancies shown by analyses of spiked badge samples indicate that the methods used to prepare such samples may have introduced an additional error. Because the sources of the apparent errors were not determined in this study, further validation of the organic monitoring badges seems necessary.

TABLE 29. TOTAL METHOD PRECISION DETERMINED BY ANALYSES OF COLLOCATED BADGE SAMPLES

	Laboratory	C.V. at Site A,[a] %	C.V. at Site E,[b] %
3M badge	PEDCo	25.3	14.2
3M badge	TRW	9.3	21.3
Du Pont badge	PEDCo	6.3	21.5
Du Pont badge	TRW	41.0	12.5

[a] Low PERC concentrations.

[b] High PERC concentrations.

REFERENCES

1. U.S. Environmental Protection Agency, "Measurement of Perchloroethylene in Ambient Air," February 1979.

2. G. W. Sneder and W. C. Cochran, Iowa State University Statistical Methods 1967.

3. W. C. Cochran, Harvard University, Sampling Techniques 1963.

APPENDIX A

LABORATORY ANALYTICAL PROCEDURES

PEDCo PERCHLOROETHYLENE ANALYSIS PROCEDURES

PERCHLOROETHYLENE ANALYSIS

I. Sample Preparation

  A. Sample Storage - 0°C. until ready for desorption.

  B. Desorption Solvent - 25% CS_2 in MeOH containing 11.6 µg/ml. of 1,4-dichlorobutane (Internal Standard).

  C. Internal Standard - 11.6 µg/ml. of 1,4-dichlorobutane. The samples run on GC/MS are calculated using the internal standard procedure. Those run on FID are calculated using an external standard procedure.

  D. Sample Desorption

    1. Charcoal tubes - both sections of the tube are placed in a 4.0 ml. glass vial. 1.0 ml. of the desorption solvent is added. Samples are sonicated for 5 min. and allowed to sit at room temperature for 1 hr. prior to analysis.

    2. 3M Vapor Monitors - 1.5 ml. of desorption solvent is added to the badge, and the badges are allowed to sit for at least 30 min. with occasional gentle shaking. After 30 min. the solvent is transferred to 4.0 ml. glass vials.

    3. Dupont Vapor Monitors - The contents of the monitor is transferred to a 4.0 ml. glass vial, 1.0 ml. of desorption solvent is added, and the mixture is allowed to sit with occasional gentle shaking for at least 1 hr.

E. Sample Analysis - GC-FID Method - this instrument is used to analyze samples for which the perc. conc. is between 0.15 µg/µl. to 8.1 µg/µl.

1. Column - 6' x 2mm. ID. glass coil packed with 0.1% SP1000 on 80/100 mesh Carbopak C.

2. Operating Parameters

Oven - 135°C. isothermal
Injector - 220°C.
Detector - 240°C.
Carrier Gas - N_2 at 30 cc/min.

3. Quantitation

$$\frac{\text{Peak Area}}{\text{Inj. volume(ml)}} \div \text{R.F. } \left(\frac{\text{A.U.}}{\mu\text{g.}}\right) \times \frac{\text{Final Vol.}}{\text{D.E.}} = \text{Total } \mu\text{g.}$$

where RF = response factor in area units/µg.
DE = desorption efficiency

F. Sample Analysis - GC/MS Method - this procedure is used to analyze samples for which the perc. concentration is between 0.4 ng/µl. and 0.3 µg/µl.

1. Instrument - Hewlett-Packard 5992 quadrupole GC/MS.

2. Column - same as for FID analysis.

3. Operating Parameters

Oven - 170°C. Isothermal
Injection Port - 225°C.
Separator - 200°C.
Solvent Elution Time - 5.0 min.
Carrier He at 20 cc/min.

4. Single Ion Monitoring Conditions

Perchloroethylene - monitor m/e 166
1,4-dichlorobutane - monitor m/e 55
Dwell times - 750 µ seconds
Window size - 0.20 amu.

5. Quantitation - blank value is subtracted from all runs made on GC/MS.

$$\left(\frac{\text{Peak Area}}{\text{Area I.S.}} - \frac{\text{Area Blank}}{\text{Area I.S.}}\right) \div \frac{\text{Area Std.}}{\text{Area I.S.}} \times \frac{\text{Final Volume}}{\text{D.E.}} = \text{Total}$$

G. Desorption Efficiency

1. Charcoal Tubes

   Test 1 - GC-FID - 1600 μg. of Perc. loaded onto each of three (3) charcoal tubes. Recoveries were 74%, 78%, and 78%.

   Test 2 - GC/MS - 40 μg. of Perc. loaded onto each of three (3) charcoal tubes. Recoveries were 75%, 77%, and 72%.

2. 3M Vapor Monitors

   Test 1 - GC-FID - 1600 μg of Perc loaded onto each of two (2) monitors. Recoveries were 69% and 69%.

   Test 2 - GC/MS - 40 μg. of perc. loaded onto each of two (2) monitors. Recoveries were 74% and 77%.

3. Dupont Vapor Monitors

   Test 1 - GC/FID - 1600 μg. of perc. loaded onto each two (2) monitors. Recoveries were 57% and 58%.

   Test 2 - GC/MS - 40 μg. of perc. were loaded onto each of two (2) monitors. Recoveries were 58% and 65%.

H. Quality Control

1. At least 2 midpoint stds. run each morning to check to see if the points fall on the standard curve. If not, a new standard curve was made.
2. Duplicate runs - every 10th sample.
3. A midpoint standard run at the end of each day to be sure that no instrument drift has occured.

4. Front and back halves analyzed separately on every 20th tube.
5. Standard Dilutions made up fresh every three weeks.
6. Reference standards run once a week to verify accuracy of the method.
7. GC/MS calibrated on a daily basis.
8. External QC samples analyzed on a daily basis.

TRW PERCHLOROETHYLENE ANALYSIS PROCEDURES

TRW ANALYTICAL PROCEDURES FOR THE ANALYSIS OF PERCHLOROETHYLENE ON CHARCOAL TUBES, AND BADGES.

I. Charcoal Tubes and DuPont Badges by GC/FID

1 - Instrument: Varian 3700 GC

2 - Column: 20' x 1/8" stainless steel, 10% SP-1000 on Supelcoport 60/80 mesh

3 - Flow rates: He - 30 ml/min., Air - 300 ml/min., H_2 - 30 ml/min.

4 - Temperatures Oven 100°C, detector 250°C, injector 250°C

5 - Integration - Varian CDS-111, Attenuation 128 x 10^{-11}

6 - Standards - 1.63 mg/ml, 4.89 mg/ml, 8.15 mg/ml; Retention time 8.0 min.

Slope: 1060805
Correlation: 0.99983
Intercept: - 98.6
0 area cts = 93 nanograms/ml

7 - Desorption - One (1) ml of MCB "Omni Solve" CS_2 was used, then vibrated for 30 min. Two (2) microliter injections were made for standards and samples.

II. 3M Badges by GC/FID

1 - All conditions, column, integration, standards, temperatures and solvent were the same as used with charcoal tubes and DuPont Badges except

- o Solvent volumn for desorption was 1.5 ml CS_2 as recommended by manufacturer with desorption directly in badge. The CDS-111 integrator calculation factor was modified to correct for the dilution factor of 1:1.5.

III. Charcoal Tubes by GC/ECD

1 - Instrument: Varian 3700 GC with Ni^{63} ECD

2 - Column: 6' x 2 mm glass, 0.1% SP-1000 on Carbopack C 80/100 mesh.

3 - Carrier gas: 5% methane in argon @ 31 ml/min.

4 - Temperatures: Oven 130°C, detector 300°C, injector 250°C

5 - Integration was performed on a Varian CDS-111, attenuation 10 x 1024

6 - Standards - 0.244 µg/ml, 2.44 µg/ml, 4.89 µg/ml, Blank CS_2/methanol

Slope: 861955
Correlation: 0.9975
Intercept: 17329
0 area cts = 0.02 µg/ml
Blank 25% CS_2/methane = 0.07 µg/ml

7 - Desorption - One (1) ml mixture of 25% CS_2 in Methanol was added to charcoal, ultrasonicated for 5 min. then allowed to stand for at least 1 hour before analysis. CS_2 was MCB "Omni Solve" brand and methanol was Burdick and Jackson "distilled in glass" brand.

RTI PERCHLOROETHYLENE ANALYSIS PROCEDURES

Procedures: Analysis of Tubes and Badges
Perchloroethlyene Study

I. INSIDE TUBES

Instrumentation

Hewlett-Packard 5880A automated GC

Column: 20' x 1/8 " stainless steel

10% - SP-1000 on 80/100 Supelcoport

Temperature: 125°C Isothermal

Flow: 29mL/min He

Detector: FID

Standards

A stock solution was made by pipeting 0.5 mL (500 μL) of perchloroethylene into a 50 mL volumetric flask and q.s. with carbon disulfide (100%). Serial dilutions were made according to the attached scheme.

Calibration

A seven point calibration was made daily.

Range: 6.194 μg/mL to 16,130 μg/mL

Correlation coefficient of first standardization: 0.999999

A daily check of all seven calibration points immediately before recalibration indicated a 24 hour-drift of no more than 3%, with a drift usually less than 1%.

All standards, samples, and QA's were auto injected with a sample volume of ~4.5 μl.

Desorption

All inside tubes were desorbed with 1.0 mL 100% carbon disulfide in a 3 mL vial, agitated with a NIOSH charcoal tube developer for at least one hour. Both the back and front of the tube were desorbed.

No dilutions of the samples were made.

Inside Badges

Instrumentation: Same as above.

Standards: Same as above.

Calibration: Same as above.

Desorption: DuPont Badge: The "charcoal" strip was removed from the holder, cut into small pieces, placed in a desorption vial with one mL of CS_2 and agitated for at least one hour.

3M Badges: 1.0 mL of CS_2 was pipetted directly into the badge, which was allowed to stand for at least one hour with occasional agitation.

PERCHLOROETHYLENE STANDARDS

INSIDE TUBES

d_4^{20} = 1.613 mg/uL

Solvent = carbon disulfide

#1 $$\frac{500\ \mu L \times 1.613\ mg/\mu L \times 1000\ \mu g/mg}{50\ mL} = 16{,}130\ \mu g/mL$$

STD. #2 15 mL of #1 q.s 25 mL (15/25) x 16130 = 9678 µg/mL

STD. #3 10 mL of #2 q.s 25 mL (10/25) x 9678 = 3871.2 µg/mL

STD. #4 10 mL of #3 q.s 25 mL (10/25) x 3871.2= 1548.48 µg/mL

STD. #5 10 mL of #4 q.s 25 mL (10/25) x 1548.48 = 619.4 µg/mL

STD. #6 1 mL of #1 q.s 100 mL (1/100) x 16130 = 161.30 µg/mL

STD. #7 0.5 mL of #5 q.s 50 mLs (0.5/50) x 619.4 = 6.194 µg/mL

II. OUTSIDE TUBES

Instrumentation

PE-3920B with Electron Capture Detector
Carrier: 5% Methane - 95% Argon 27 mL/min
Column: 6 ft x 1/4" glass 0.1 % SP-1000
Temp: 150°C Isothermal

Standards

A stock solution was made by pipetting 10 μL of perchloroethylene into a volumetric flask and diluting to the mark with solvent composed of 25% carbon disulfide and 75% methanol. Serial dilutions were made according to the attached schedule.

Calibration

A five point calibration curve was made daily. Two μL of standard were injected in triplicate, and the average of the three injections, minus the blank, was used. No more than 12 samples were run before a new calibration curve was made. Every sample and every QC was injected in triplicate. Range of calibration: 0.6452 μg/mL to 6.452 μg/mL.

Desorption

All outside tubes[1] (and outside QC's) were desorbed with 2 mL of 25% CS_2/75% MeOH in a 3 mL vial and agitated with a NIOSH charcoal tube developer for a least one hour. Because 2 mL were used for desorption, no dilutions were necessary.

---

[1] A few of the outside samples were desorbed with 100% of CS_2 when it was thought that all of the samples might be done by FID. These samples were later diluted 3:1 with MeOH and analyzed by EC. None of the QC's were analyzed in this fashion.

PERCHLOROETHYLENE STANDARDS
OUTSIDE TUBES

$d_4^{20} = 1.613$ mg/μL

Solvent = 25% carbon disulfide,
75% methanol

Stock standard:

$$\frac{1000\ \mu g/mg \times 1.613\ mg/\mu L \times 10\ \mu L}{100\ mL} = 161.3\ \mu g/mL$$

1 mL q.s. 10 mL = $\underline{16.13\ \mu g/mL}$

STD. #1 2 mL stock std q.s. 5 mL = $\frac{2 \times 16.13}{5}$ = 6.452 μg/mL

STD. #2 1.5 mL stock std q.s. 5 mL = $\frac{1.5 \times 16.13}{5}$ = 4.848 μg/mL

STD. #3 1 mL stock std q.s. 5 mL = 6.452/5 = 1.290 μg/mL

STD. #4 1 mL STD #1 q.s. 10 mL = 6.452/10 = 0.6452 μg/mL

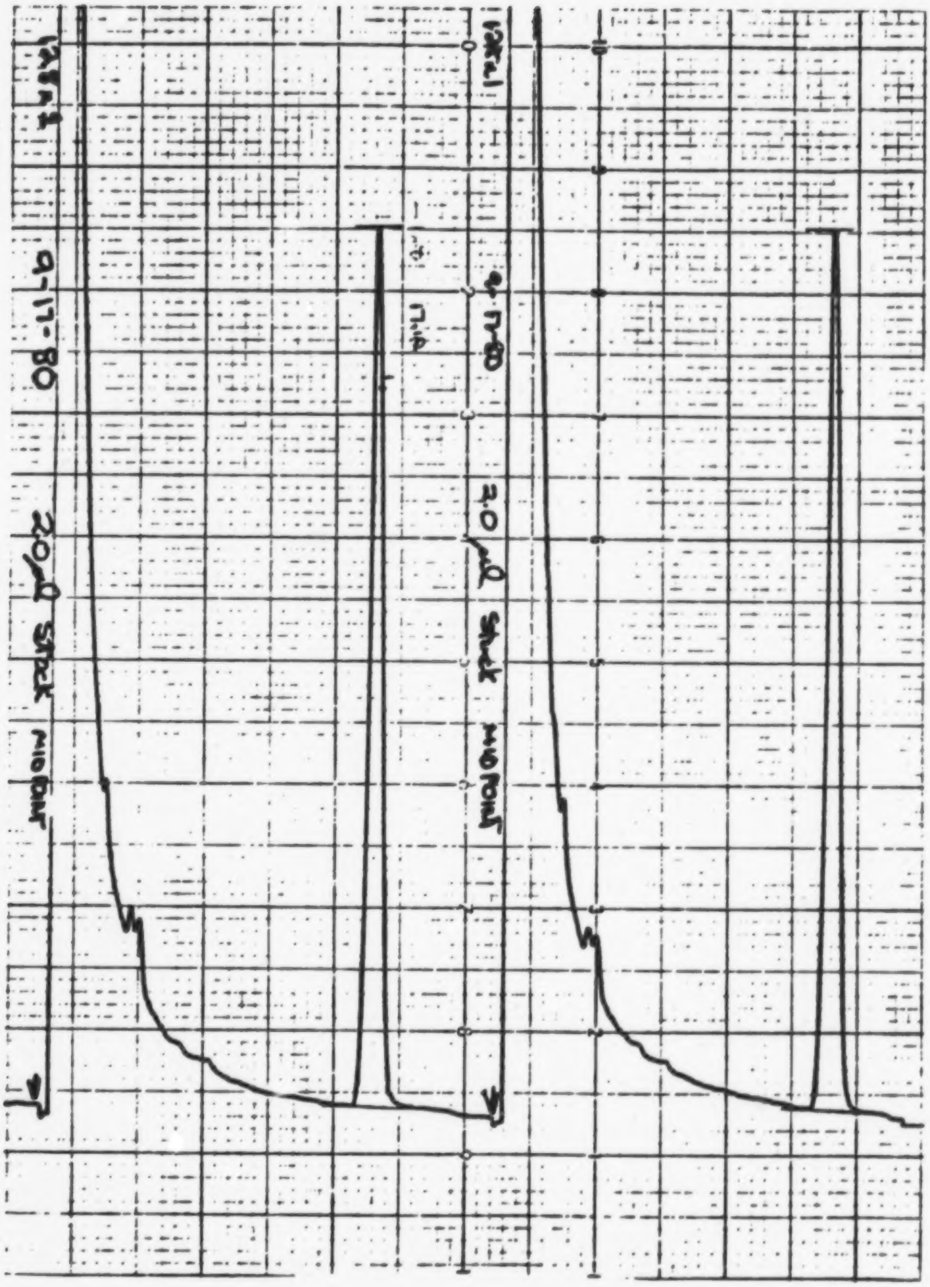


Figure A-1. Typical chromatogram showing duplicate GC/FID analysis of 1623 µg/ml standard by PEDCo.

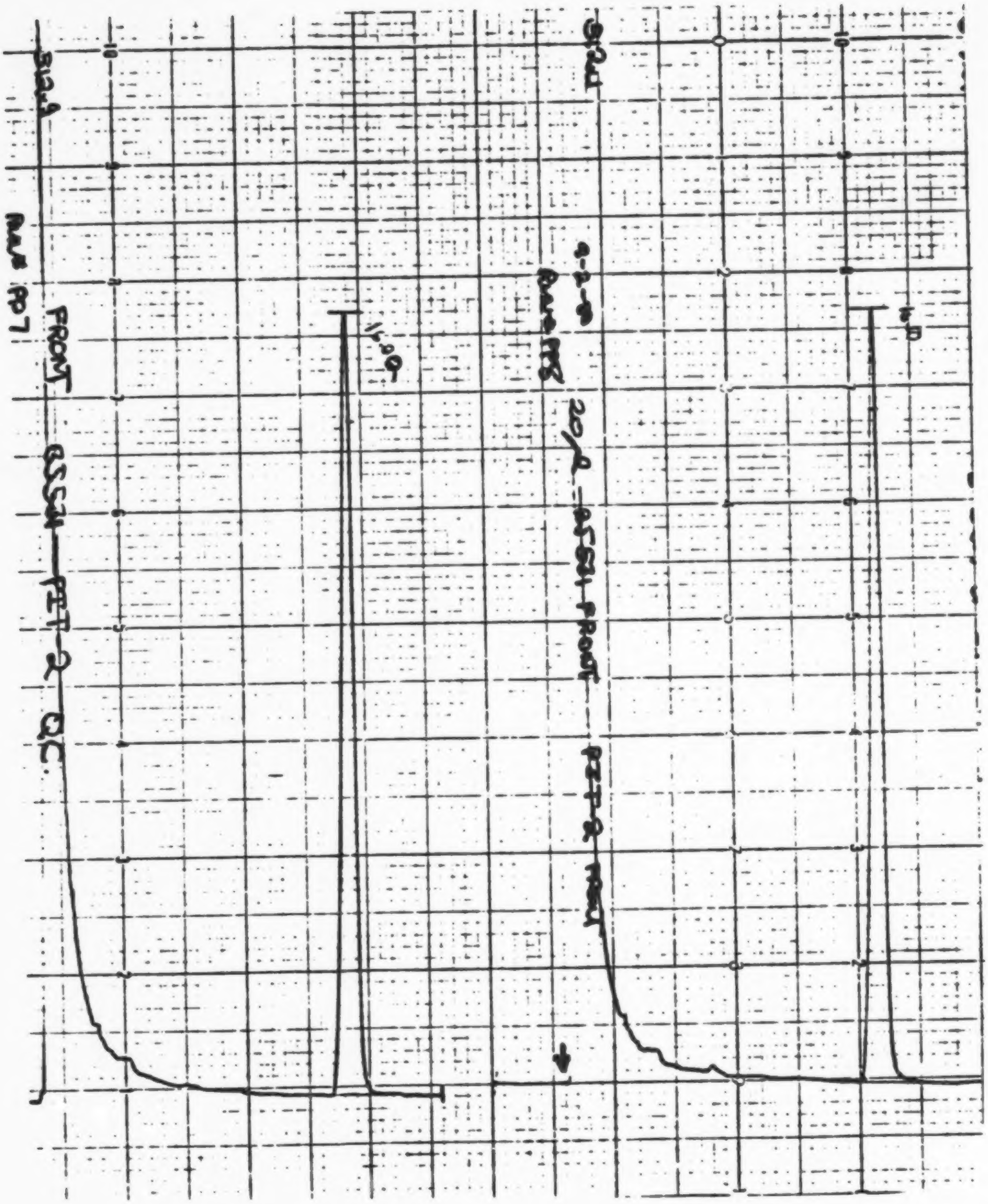


Figure A-2. Typical chromatogram showing duplicate analysis of QC spiked sample PIT-2 by PEDCo.

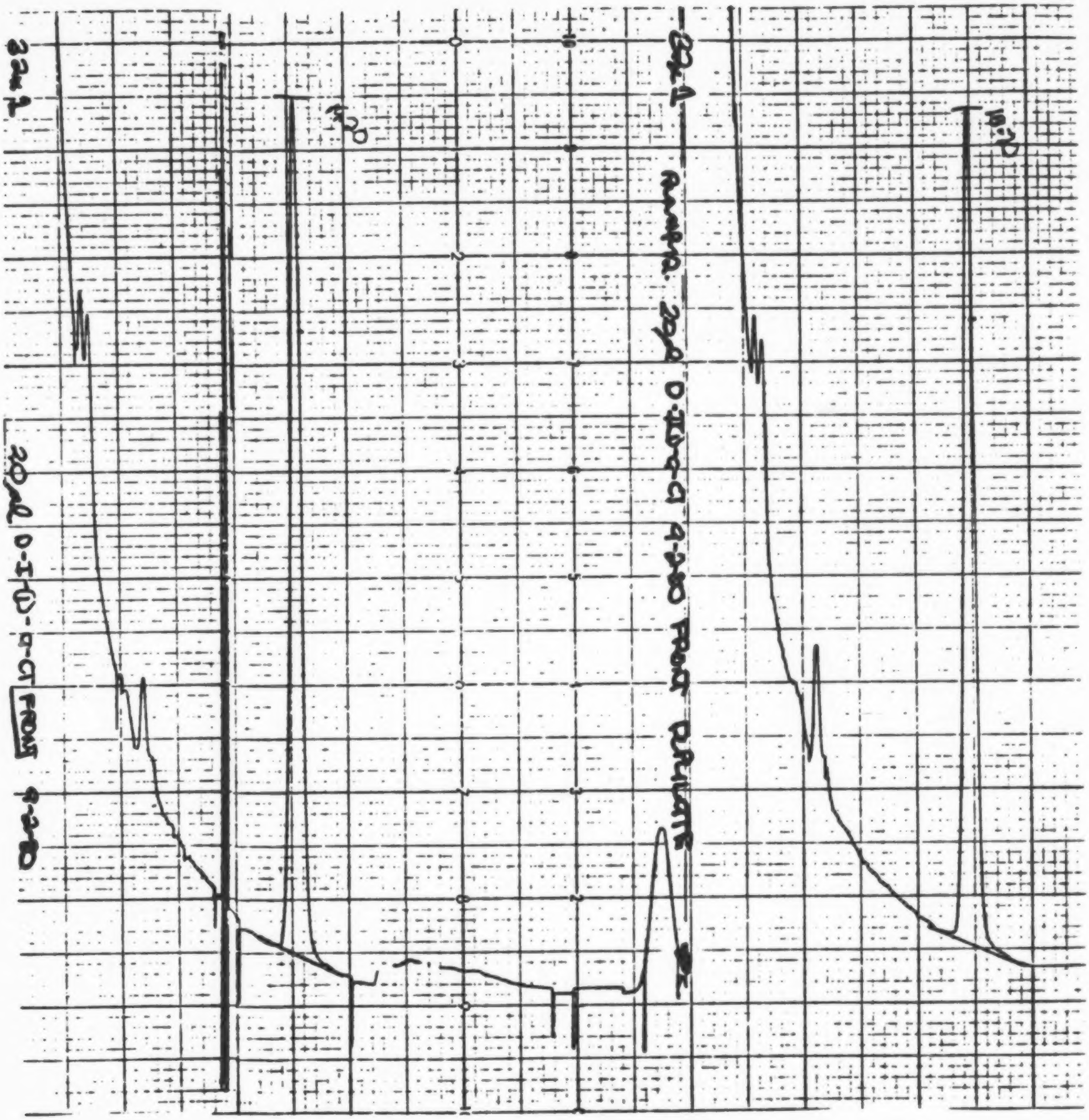
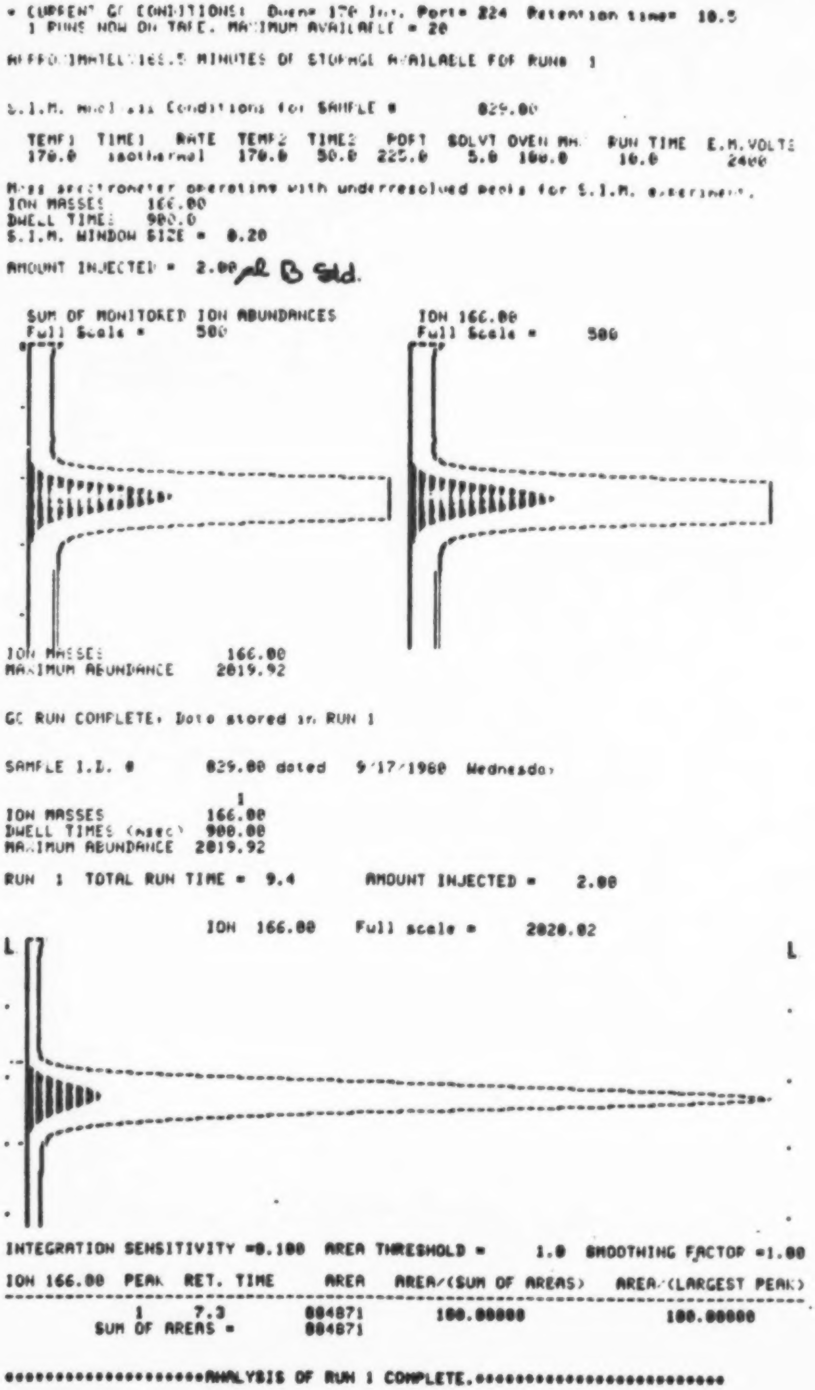
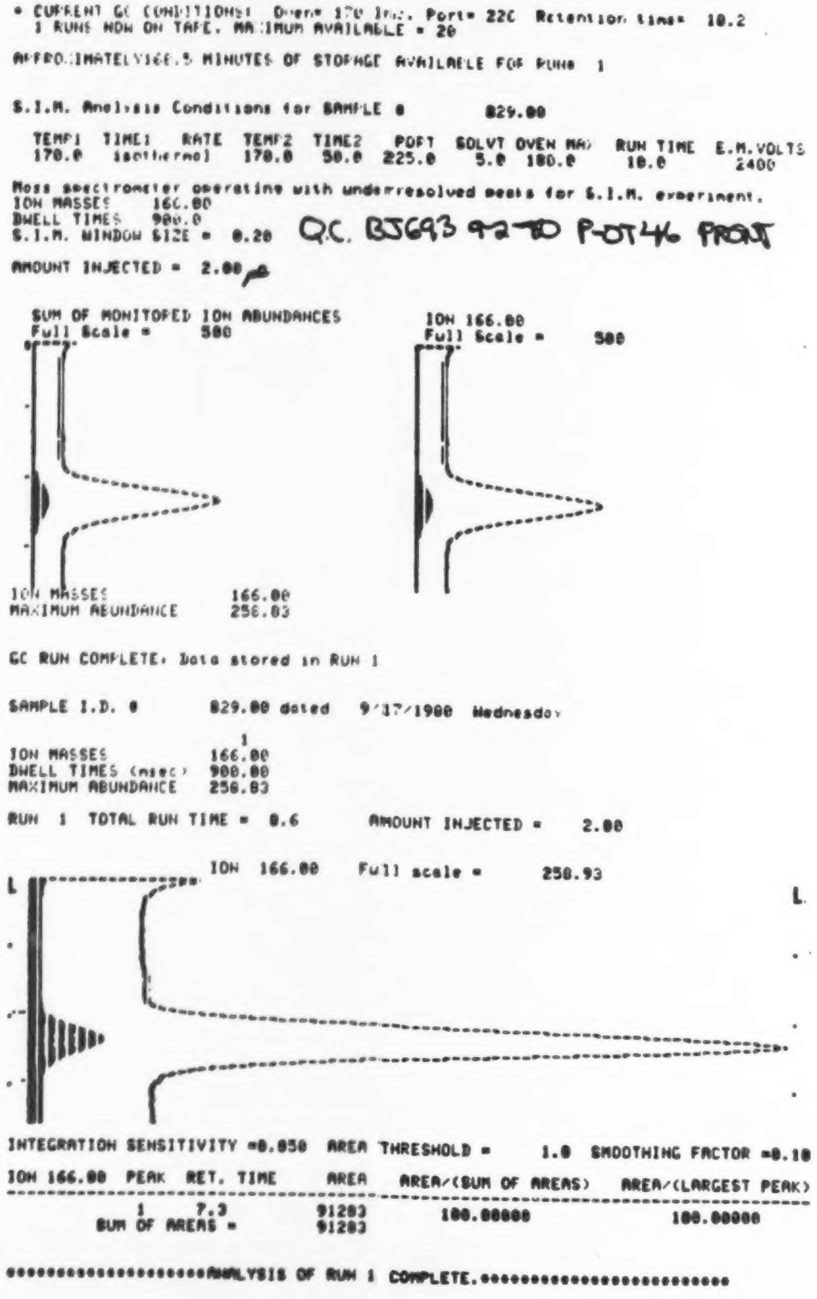


Figure A-3. Typical chromatogram showing duplicate analysis of Sample D-I-(1)-a CT from 9/2/80, by PEDCo.



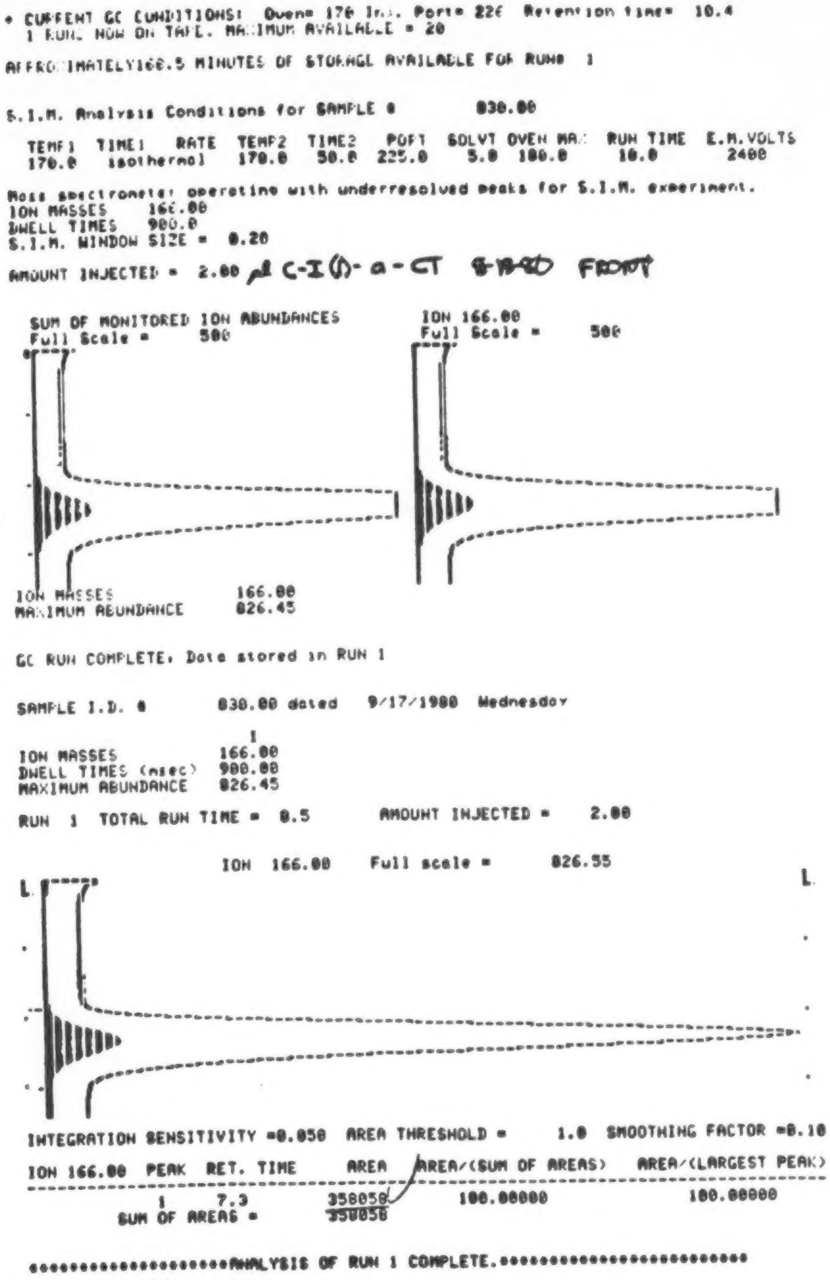
```
* CURRENT GC CONDITIONS:  Oven= 170 Inj. Port= 224  Retention time=  10.5
  1 RUNS NOW ON TAPE. MAXIMUM AVAILABLE = 20

APPROXIMATELY 165.5 MINUTES OF STORAGE AVAILABLE FOR RUN#  1

S.I.M. Analysis Conditions for SAMPLE #        829.00

  TEMP1  TIME1   RATE  TEMP2  TIME2   PORT  SOLVT OVEN MAX  RUN TIME  E.M.VOLTS
  170.0   isothermal   170.0   50.0  225.0    5.0  100.0      16.0       2400

Mass spectrometer operating with underresolved peaks for S.I.M. experiment.
ION MASSES    166.00
DWELL TIME:   900.0
S.I.M. WINDOW SIZE =  0.20

AMOUNT INJECTED =  2.00 μl B Std.

  SUM OF MONITORED ION ABUNDANCES          ION 166.00
  Full Scale =      500                    Full Scale =      500

ION MASSES               166.00
MAXIMUM ABUNDANCE       2019.92

GC RUN COMPLETE, Data stored in RUN 1

SAMPLE I.D. #        829.00 dated   9/17/1980  Wednesday

                          1
ION MASSES             166.00
DWELL TIMES (msec)     900.00
MAXIMUM ABUNDANCE     2019.92

RUN  1  TOTAL RUN TIME =  9.4       AMOUNT INJECTED =    2.00

                  ION  166.00    Full scale =     2020.02

INTEGRATION SENSITIVITY =0.100  AREA THRESHOLD =     1.0  SMOOTHING FACTOR =1.00
ION 166.00  PEAK  RET. TIME     AREA   AREA/(SUM OF AREAS)   AREA/(LARGEST PEAK)
-------------------------------------------------------------------------------
             1      7.3        004871       100.00000              100.00000
        SUM OF AREAS =         004871

***********************ANALYSIS OF RUN 1 COMPLETE.****************************
```

Figure A-4. Typical GC/MS printout showing analysis of 40.58 μg/ml standard by PEDCo.



```
* CURRENT GC CONDITIONS:  Oven= 170 Inj. Port= 220  Retention time=  10.2
  1 RUNS NOW ON TAPE. MAXIMUM AVAILABLE = 20

APPROXIMATELY166.5 MINUTES OF STORAGE AVAILABLE FOR RUN#  1

S.I.M. Analysis Conditions for SAMPLE #        829.00

  TEMP1  TIME1   RATE  TEMP2  TIME2   PORT  SOLVT OVEN MAX  RUN TIME  E.M.VOLTS
  170.0  isothermal   170.0   50.0  225.0    5.0  180.0     10.0       2400

Mass spectrometer operating with underresolved peaks for S.I.M. experiment.
ION MASSES    166.00
DWELL TIMES   900.0
S.I.M. WINDOW SIZE =  0.20   Q.C. BJ693 9-2-80 P-OT46 FRONT

AMOUNT INJECTED =  2.00 µl

  SUM OF MONITORED ION ABUNDANCES               ION 166.00
  Full Scale =      500                         Full Scale =     500

ION MASSES              166.00
MAXIMUM ABUNDANCE       258.83

GC RUN COMPLETE, Data stored in RUN 1

SAMPLE I.D. #        829.00 dated   9/17/1980  Wednesday

                        1
ION MASSES           166.00
DWELL TIMES (msec)   900.00
MAXIMUM ABUNDANCE    258.83

RUN  1  TOTAL RUN TIME =  0.6        AMOUNT INJECTED =    2.00

                    ION  166.00    Full scale =      258.93

INTEGRATION SENSITIVITY =0.050  AREA THRESHOLD =     1.0  SMOOTHING FACTOR =0.10
ION 166.00  PEAK  RET. TIME      AREA   AREA/(SUM OF AREAS)   AREA/(LARGEST PEAK)
----------------------------------------------------------------------------------
              1      7.3        91283        100.00000               100.00000
         SUM OF AREAS =         91283

**********************ANALYSIS OF RUN 1 COMPLETE.*****************************
```

Figure A-5. Typical GC/MS printout showing analysis of QC sample POT46 by PEDCo.



```
* CURRENT GC CONDITIONS: Oven= 170 Inj. Port= 226  Retention time=  10.4
  1 RUNS NOW ON TAPE. MAXIMUM AVAILABLE = 20

APPROXIMATELY166.5 MINUTES OF STORAGE AVAILABLE FOR RUN#  1

S.I.M. Analysis Conditions for SAMPLE #          030.00

  TEMP1  TIME1   RATE  TEMP2  TIME2   PORT  SOLVT OVEN MAX  RUN TIME  E.M.VOLTS
  170.0   isothermal   170.0   50.0  225.0    5.0  100.0     10.0        2400

Mass spectrometer operating with underresolved peaks for S.I.M. experiment.
ION MASSES     166.00
DWELL TIMES    900.0
S.I.M. WINDOW SIZE =  0.20

AMOUNT INJECTED =  2.00 µl C-I(1)-a-CT  8-18-80  FRONT

  SUM OF MONITORED ION ABUNDANCES          ION 166.00
  Full Scale =      500                    Full Scale =      500

ION MASSES              166.00
MAXIMUM ABUNDANCE       026.45

GC RUN COMPLETE, Data stored in RUN 1

SAMPLE I.D. #        030.00 dated   9/17/1980  Wednesday

                       1
ION MASSES           166.00
DWELL TIMES (msec)   900.00
MAXIMUM ABUNDANCE    026.45

RUN  1  TOTAL RUN TIME =  0.5        AMOUNT INJECTED =    2.00

                  ION  166.00    Full scale =      026.55

  INTEGRATION SENSITIVITY =0.050  AREA THRESHOLD =     1.0  SMOOTHING FACTOR =0.10

  ION 166.00  PEAK  RET. TIME       AREA   AREA/(SUM OF AREAS)   AREA/(LARGEST PEAK)
  --------------------------------------------------------------------------------
                1      7.3         358058        100.00000              100.00000
          SUM OF AREAS =           358058

  **********************ANALYSIS OF RUN 1 COMPLETE.*****************************
```

Figure A-6. Typical GC/MS printout showing analysis of sample C-I-(1) a CT (8/18/80) by PEDCo.

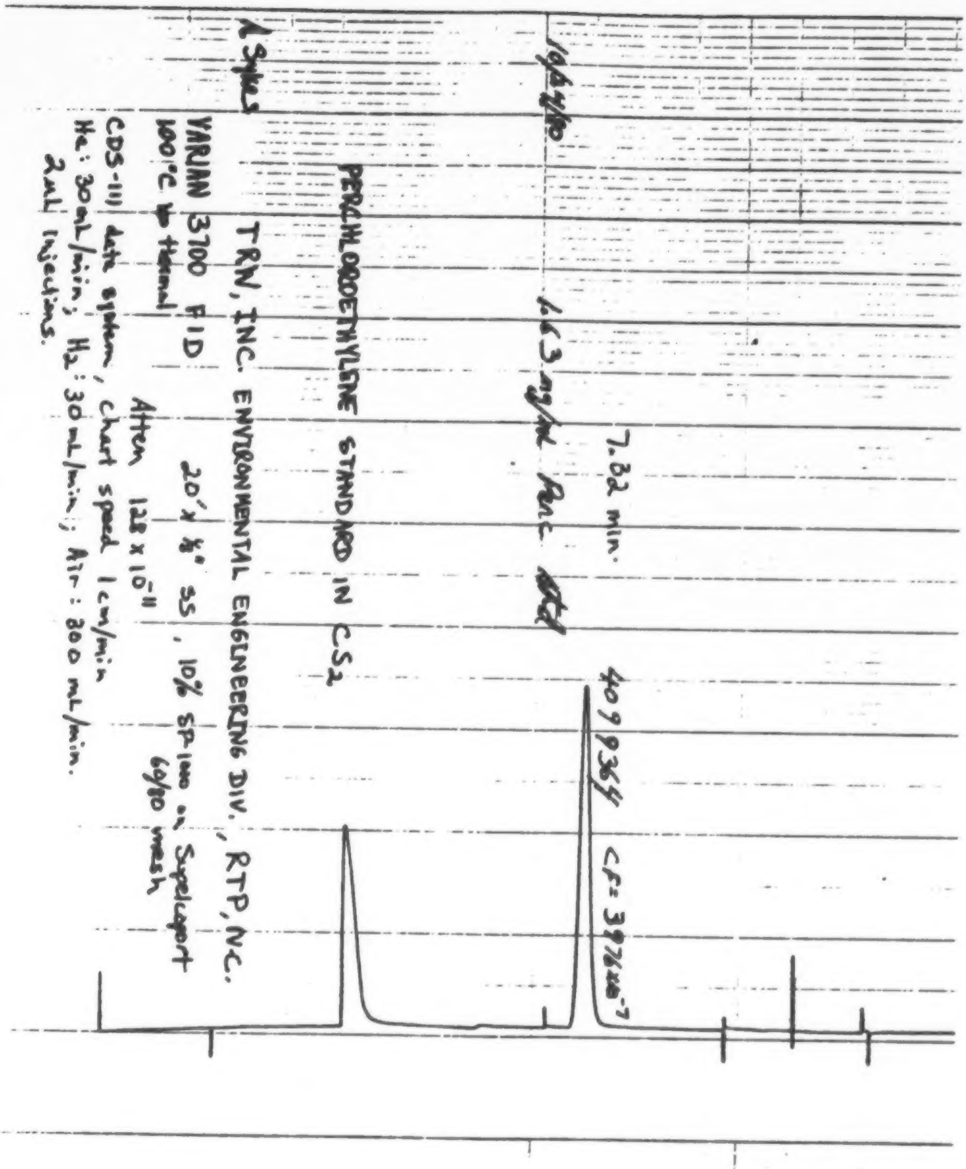
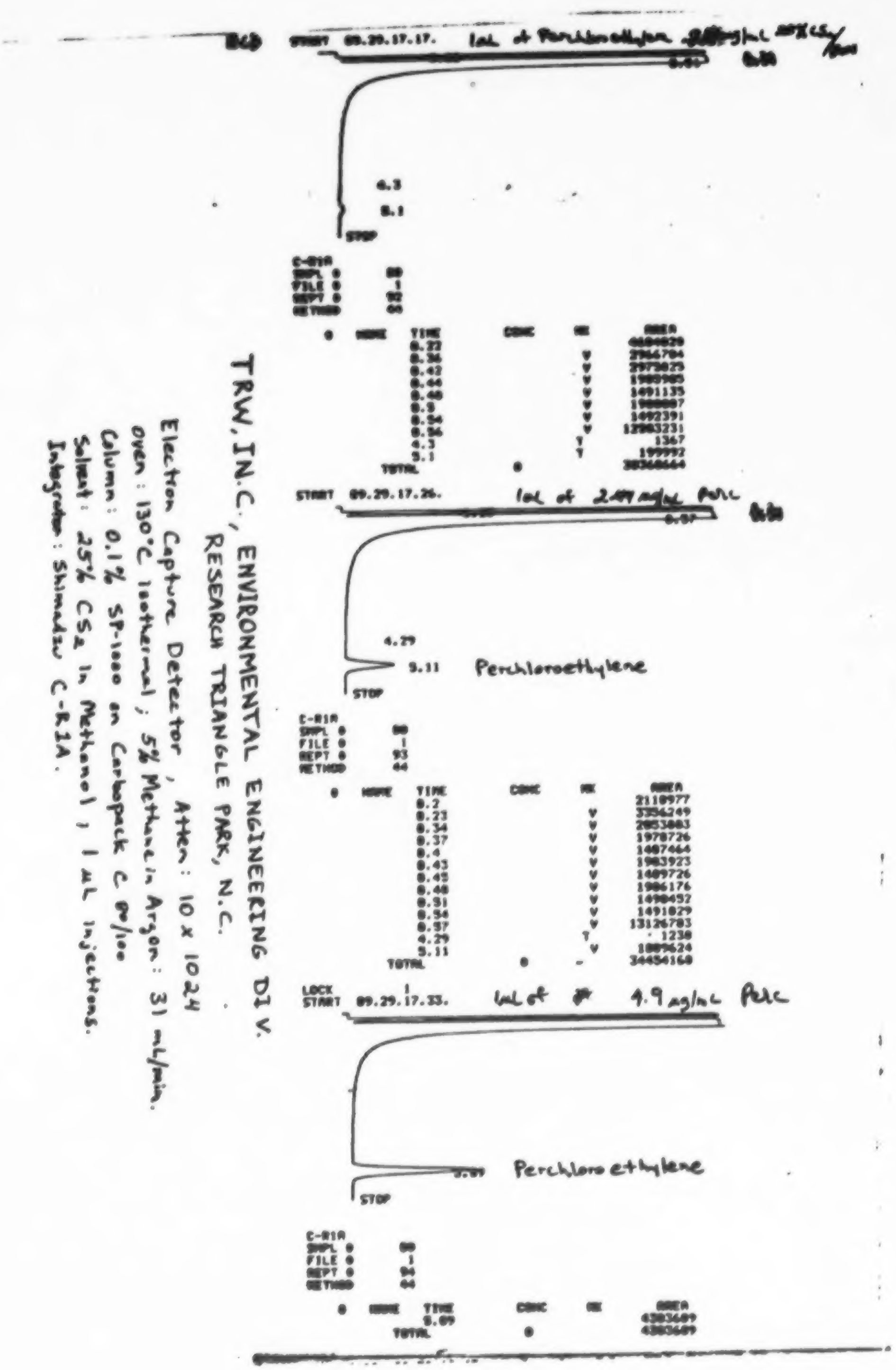


Figure A-7. Typical chromatogram showing GC/FID analysis of 1.63 mg/ml PERC standard by TRW.



START 09.29.17.17. 1uL of Perchloroethylene [illegible]

4.3

5.1

STOP

C-R1A

START 09.29.17.26. 1uL of 2.44 µg/mL Perc

4.29

5.11 Perchloroethylene

STOP

C-R1A

LOCK
START 09.29.17.33. 1uL of 4.9 µg/mL Perc

Perchloroethylene

STOP

C-R1A

TRW, INC., ENVIRONMENTAL ENGINEERING DIV.
RESEARCH TRIANGLE PARK, N.C.

Electron Capture Detector, Atten: 10 x 1024
Oven: 130°C Isothermal; 5% Methane in Argon: 31 mL/min.
Column: 0.1% SP-1000 on Carbopack C 80/100
Solvent: 25% CS_2 in Methanol; 1 µL injections.
Integrator: Shimadzu C-R1A.

Figure A-8. Typical chromatogram/printout showing GC/ECD analyses of 0.24, 2.44, and 4.9 µg/ml PERC standards by TRW.

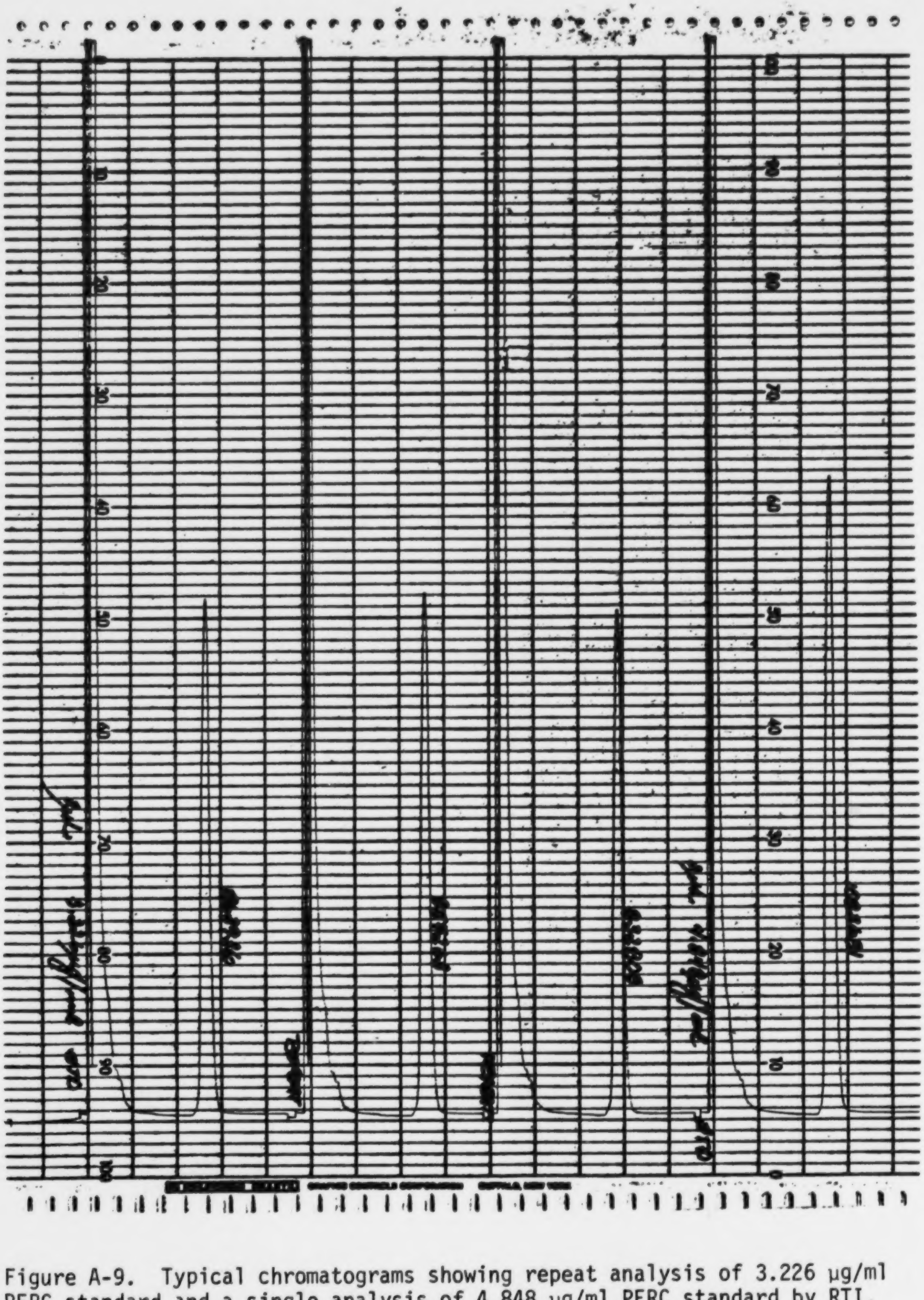


Figure A-9. Typical chromatograms showing repeat analysis of 3.226 μg/ml PERC standard and a single analysis of 4.848 μg/ml PERC standard by RTI.

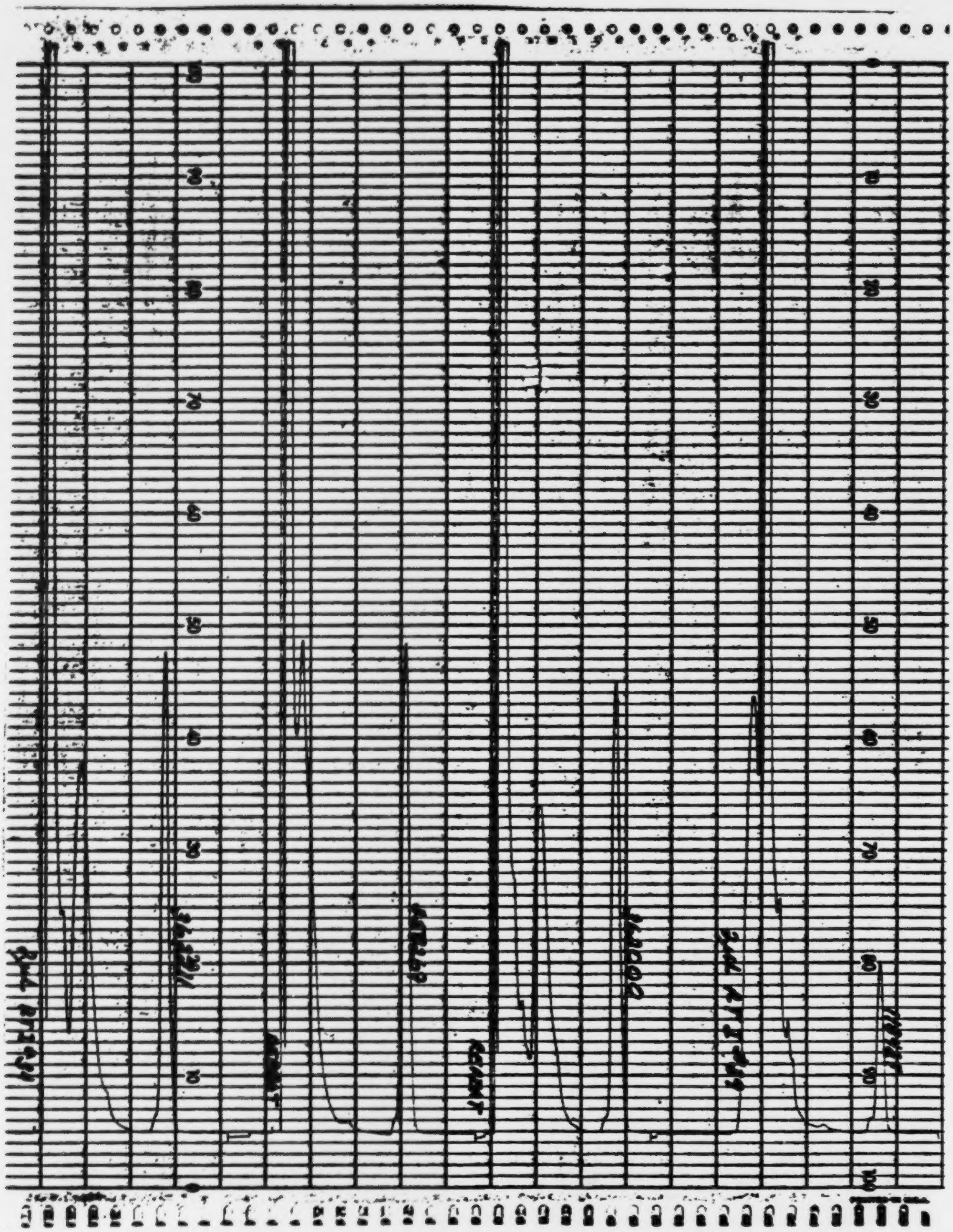
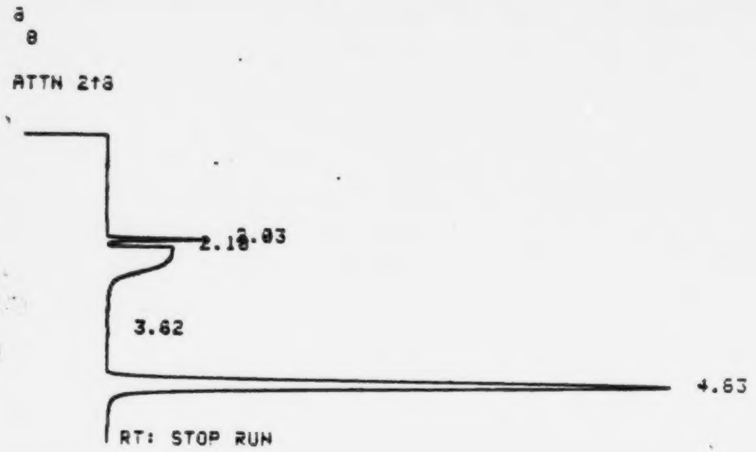
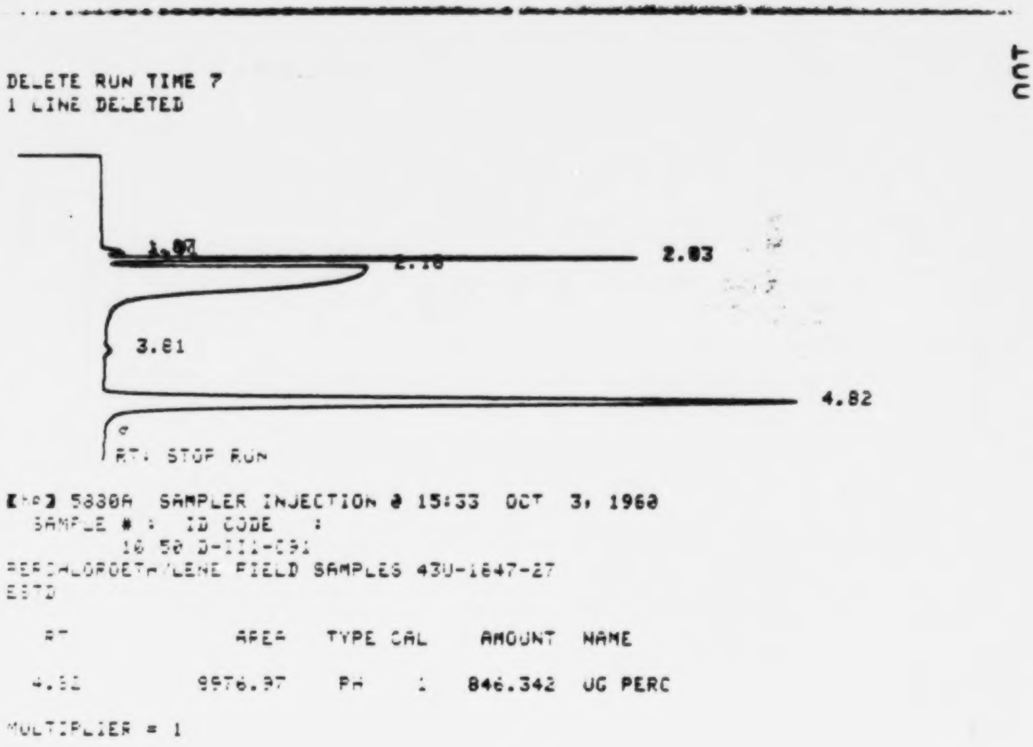


Figure A-10. Typical chromatograms showing GC/FID analyses of field samples by RTI.



```
[hp] 5880A  SAMPLER INJECTION @ 11:44  OCT  1, 1980
  SAMPLE # :  ID CODE   :
        60    QC-P-IT17
PERCHLOROETHYLENE FIELD SAMPLES 43U-1847-27
ESTD

   RT              AREA   TYPE CAL    AMOUNT  NAME

  4.83          29070.40    BB    1  2827.870  UG PERC

MULTIPLIER = 1

PR: STOP PROGRAM AT LINE 110

ATTN 2↑6

START PRGM

ENTER THE FIRST SAMPLE NUMBER:7
ENTER THE  LAST SAMPLE NUMBER:21
```

Figure A-11. Typical chromatogram/printout showing GC/ECD analysis of Quality Control Sample PIT-17 by RTI.



```
DELETE RUN TIME 7
1 LINE DELETED

RT: STOP RUN

[HP] 5830A  SAMPLER INJECTION @ 15:33  OCT  3, 1980
  SAMPLE # :  ID CODE    :
         10 50 D-III-C91
PERCHLOROETHYLENE FIELD SAMPLES 430-1647-27
ESTD

   RT              AREA   TYPE CAL    AMOUNT  NAME

  4.82         9976.97    PH    1   846.342  UG PERC

MULTIPLIER = 1
```

Figure A-12. Typical chromatogram/printout showing GC/ECD analysis of Field Sample D-III-9/1 by RTI.

APPENDIX B

AMBIENT PERC CONCENTRATION DATA

The following data represent computations based on:

(1) Total micrograms of PERC per sample, as reported by laboratory

(2) Mean sample flow rates, in standard ml/m, averaged from field data (charcoal tube method) or from manufacturer data (badge sampling method)

(3) Sample volume in standard liters from sampling time x sampling rate

(4) ppb from the following calculation:

$$\text{ppb} = (\frac{\mu g}{165.8 \times 10^6} \times \frac{\text{sample volume l}}{24.47} \times 10^9$$

where 165.8×10^6 = μg PERC/mole PERC
24.47 = liters air/mole, standard
10^9 = conversion to ppb

(5) Corrected ppb, by multiplying ppb by $\frac{1}{D,E}$, where D,E is determined from QA results (charcoal tube method) or from manufacturer data (badge sampling method)

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 1
Checked By H.B.E. Date 11-25-80
Computed By AH Date 8/24

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total ug found	Desorption efficiency (D.E.)	Mean sample flow rate, C^3/m	Sample volume, l	PPB	Corrected PPB	
A-I(1)a CT 8/16	PE I	BK126	16.82		58.6	33.0	75.2	87.0	
A-I(1)b CT 8/16	PE I	BK127	17.75		54.7	31.1	84.2	97.5	
A-I(1)c CT 8/16	PE I	BK128	14.79		53.5	30.5	71.6	82.9	
A-I(2)a CT 8/16	PE I	BK141	20.6		73.8	35.5	85.6	99.1	
A-I(2)b CT 8/16	RT1	—	16.77		65.0	31.3	79.1	89.8	
A-I(2)c CT 8/16	TRW	1698	17.6		64.7	31.1	83.5	84.8	
A-I(3)a CT 8/16	PE I	BK147	15.43		58.7	28.2	80.8	93.5	
A-I(3)b CT 8/16	PE I	BK148	18.59		61.3	29.5	93.0	107.6	
A-I(3)c CT 8/16	PE I	BK149	15.30		58.7	28.2	80.1	92.7	
A-I(1)a CT 8/17	—	—	—	—	—	—	—	—	N.S./valve leak
A-I(1)b CT 8/17	PE I	BK130	10.38		53.1	22.5	68.1	78.8	
A-I(1)c CT 8/17	—	—	—	—	—	—	—	—	N.S./valve leak
A-I(2)a CT 8/17	PE I	BK142	35.2		71.2	30.2	172	199.1	
A-I(2)b CT 8/17	RT1	—	25.83		57.2	24.3	157	178.2	
A-I(2)c CT 8/17	TRW	1700	23.3		53.6	22.7	151	163.5	
A-I(3)a CT 8/17	PE I	BK150	5.63		56.0	23.7	35.1	40.6	
A-I(3)b CT 8/17	PE I	BK151	5.60		57.8	24.5	33.7	39.0	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 2
Checked By H.B.F Date 11-25-80
Computed By JH Date 8/24

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c^3/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I(3)c CT 8/17	PEI	BK 152	6.19		60.5	25.7	35.5	41.1	
A-I(1)a CT 8/18	PEI	BK 132	24.84		61.8	31.8	115	133.1	
A-I(1)b CT 8/18	PEI	BK 133	23.47		54.7	28.2	123	142.4	
A-I(1)c CT 8/18	PEI	BK 134	23.57		59.5	30.6	114	131.9	
A-I(2)a CT 8/18	PEI	BK 143	39.75		72.0	37.1	158	152.9	
A-I(2)b CT 8/18	RTI	—	33.97		60.0	30.9	162	183.9	
A-I(2)c CT 8/18	TRW	1704	~~35.7~~ ← 34.5		62.7	32.3	158	160	
A-I(3)a CT 8/18	PEI	BK 153	28.90		62.7	32.3	132	152.8	
A-I(3) b CT 8/18	PEI	BK 154	26.13		63.5	32.7	118	136.6	
A-I(3) c CT 8/18	PEI	BK 155	28.9		56.9	29.3	146	169.0	
A-I(1)a CT 8/19	PEI	BK 135	14.42		61.0	20.9	102	118.1	
A-I(1) b CT 8/19					60.0	20.6		—	
A-I(1)c CT 8/19	PEI	BK 137	13.06		63.2	21.7	98.8	102.8	
A-I(2)a CT 8/19	PEI	BK 144	26.6		76.0	26.1	150	173.6	
A-I(2)b CT 8/19	RTI		17.13		61.0	20.9	121	137.3	
A-I(2)c CT 8/19	TRW	1701	17.7		59.0	20.2	129	131	
A-I(3)a CT 8/19	PEI	BK 156	15.82		60.5	20.8	112	129.6	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC Field Sample data

PN
Sheet No. 3
Checked By H.B.K Date 11-25-80
Computed By SH Date 11/24

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	~~Correction~~ Desorption efficiency ~~(0.? TRW)~~	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I(2) b CT 8/19	PEI	BK157	17.5		62.3	21.4	121	140.0	
A-I(3) c CT 8/19	PEI	BK158	14.21		56.0	19.2	109	126.2	
A-I(1) a CT 8/20					60.5	19.8		—	No Sample Rpt'd
A-I(1) b CT 8/20	~~PEI~~ PEI	~~BK27~~ BK139	~~17.75~~ 33.08		59.5	19.5	~~134~~ 100	115.7	
A-I(1) c CT 8/20	PEI	BK140	12.17		59.5	19.5	92.1	106.6	
A-I(2) a CT 8/20	PEI	BK145	25.89		73.8	24.2	158	182.9	Dup a.
A-I(2) b CT 8/20	RTI	–	18.2		60.5	19.8	136	154.4	
A-I(2) c CT 8/20	TRW	1703	~~19.7~~ ← 19.2		57.2	18.8	~~155~~ 151	153	
A-I(3) a CT 8/20	PEI	BK159	18.07		56.9	18.7	143	165.5	
A-I(3) b CT 8/20	PEI	BK160	18.1		56.4	18.5	144	166.7	
A-I(3) c CT 8/20	PEI	BK161	20.32		56.4	18.5	162	187.5	
A-I(1) a CT 8/21	TRW	1709	~~19.8~~ ← 18.4		61.0	25.1	~~116~~ 108.8	109	
A-I(1) b CT 8/21	TRW	1708	~~19.3~~ ← 18.1		59.5	24.5	~~116~~ 109	110	
A-I(1) c CT 8/21	TRW	1702	~~21.6~~ ← 21.2		61.3	25.3	~~126~~ 124	126	
A-I(2) a CT 8/21	PEI	BK166	16.0		71.2	29.3	80.6	93.3	
A-I(2) b CT 8/21	RTI	—	12.3		56.9	23.4	77.6	88.1	
A-I(2) c CT 8/21	TRW	1712	~~13.2~~ ← 11.8		57.8	23.8	~~81.7~~ 72.4	74.3	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
Sheet No. 4
Checked By H.B.K Date 11-25-80
Computed By S.H. Date 11/24

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C³/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I(3)aCT 8/21	TRW	1691	21.5		58.2	24.0	132	134	F&B
A-I(3)bCT 8/21	TRW	1692	20.8		61.8	25.5	120	122	F&B
A-I(3)cCT 8/21	TRW	1710	~~14.7~~	← 13.3	55.0	22.7	86.8 ~~[illegible]~~	87.8	prev. calc. error.
A-I(1)aCT 8/22	TRW	1693	31.3		61.3	25.1	184	187	F+B
A-I(1)bCT 8/22	TRW	1688	48.2		57.8	23.6	301	306	
A-I(1)cCT 8/22	TRW	1711	~~33.3~~	← 29.9	54.7	22.4	197 ~~219~~	200	
A-I(2)aCT 8/22	TRW	1705	~~49.1~~	← 47.1	70.3	28.8	245 ~~[illegible]~~	249	F&B
A-I(2)bCT 8/22	TRW	1696	22.3		59.0	24.1	137	139	
A-I(2)cCT 8/22	RTI		22.7		58.2	23.8	141	160.0	
A-I(3)aCT 8/22	TRW	1706	~~31.4~~	← 29.7	58.7	24.0	193	196	
A I(3)bCT 8/22	TRW	1697	30.8		58.2	23.8	191	194	
A I(3)cCT 8/22	TRW	1694	28.1		53.6	21.9	189	192	
B-I-(1)aCT 8/16					—	—			N.S. tube broke
B-I(1)bCT 8/16	PEI	267	42.28		53.1	8.1	770	891	
B-I(1)cCT 8/16	PEI	268	45.76		66.1	10.1	669	774	
B-I(2) CT 8/16	PEI	280	43.15		65.0	9.9	643	744	
B-I(3) CT 8/16	PEI	285	27.71		57.0	8.7	470	544	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 5
Checked By H.B.F Date 11-25-80
Computed By AH Date 11/24

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total ug found	Desorption efficiency (D.E.)	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
B-I(1)a CT 8/17	PEI	BK269	23.35		62.2	22.6	152	176	
B-I(1)b CT 8/17	PEI	BK270	22.8		61.0	22.1	152	176	
B-I(1)c CT 8/17	PEI	BK271	19.6		59.0	21.4	135	156	
B-I(2) CT 8/17	PEI	BK281	17.5		62.8	22.8	113	131	
B-I(3) CT 8/17	PEI	BK286	14.78		63.2	22.9	95.3	110.3	
B-I(1)a CT 8/18	PEI	BK272	267.01		61.7	29.3	1345	1557	
B-I(1)b CT 8/18					60.0	28.5			No sample rept'd
B-I(1)c CT 8/18	RTI		15.7		56.9	27.0	85.8	97.4	
B-I(2) CT 8/18	PEI	BK282	8.6		60.5	28.7	44.2	51.2	
B-I(3) CT 8/18	TRW	1713	~~16.8~~ 14.8		61.0	29.0	75.3 ~~[illegible]~~	76.5	
B-I(1)a CT 8/19	PEI	273	32.5		57.2	22.9	209	242	
B-I(1)b CT 8/19	PEI	BK274	39.2		59.0	23.6	245	254	
B-I(1)c CT 8/19	PEI	275	35.34		58.6	23.4	223	258	
B-I(2) CT 8/19	PEI	283	30.99		61.4	24.6	186	215	
B-I(3) CT 8/19	PEI	BK288	25.87		58.2	23.3	164	190	
B-I(1)a CT 8/20	PEI	276	51.7		51.5	20.0	382	442	
B-I(1)b CT 8/20	PEI	BK277	58.09		54.2	21.1	406	470	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC Field Sample data

PN
Sheet No. 6
Checked By H.B.K Date 11-25-80
Computed By AH Date 11/24

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, L/m	Sample volume, L	PPB	Corrected PPB	
B-I(1)c CT 8/20	PEI	278	62.35		53.5	20.8	442	512	
B-I(2) CT 8/20	PEI	BK 284	59.59		55.0	21.4	411	476	
B-I(3) CT 8/20					57.2	22.3			No Sample Rept'd
B-I(1)a CT 8/21	PEI	279	46.39		53.5	24.0	285	330	
B-I(1)b CT 8/21	TRW	1733	~~54.6~~	← 48.5	54.7	24.5	[illegible]	297	
B-I(1)c CT 8/21					56.0	25.1		---	No Sample Rept'd
B-I(2) CT 8/21	TRW	1715	~~49.5~~	← 43.3	9.5	26.7	[illegible]	243	ST. OK
B-I(3) CT 8/21					57.8	25.9		–	No sample Rept'd
B-I(1)a CT 8/22	TRW	1724	~~73.5~~	← 61.5	96.0	32.7	[illegible]	282	
B-I(1)b CT 8/22	TRW	1720	~~71.6~~	← 60.4	56.9	21.6	413 407	419	
B-I(1)c CT 8/22	RTI / TRW	– / 1716	58.4 / [illegible]	– / 52	52.0	19.8	435 / 410	494 / 477	2 VALID VALUES REPORTED
B-I(2) CT 8/22	TRW	1727	~~51.9~~	← 43.0	52.4	19.9	317 ~~325~~	324	
B-I(3) CT 8/22	TRW	1729	~~42.6~~	← 35.0	53.1	20.2	256 ~~311~~	259	
C-I(1)a CT 8/16	PEI		23.8	—	62.7	18.6	189	219	
C-I(1)b CT 8/16	TRW	1734	~~38.6~~	← 29.9	59.0	17.5	[illegible]	256	
C-I(1)c CT 8/16	RTI		38.2		55.6	16.5	252	256	
C-I(2) CT 8/16	PEI	BK321	17.4		58.7	17.4	148	171	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 7
Checked By AH Date 11/25/80
Computed By H.DK. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total ug found	Desorption efficiency (D.E.)	Mean sample flow rate, C³/m	Sample volume, ℓ	PPB	Corrected PPB	
C-I(3)-CT 8/16	PEI	BK 327	37.6		63.2	18.8	294.9	341.3	
C-I(1)-a CT 8/17	PEI		197.2		60.5	21.8	1333.8	1543.8	
C-I(1)-b CT 8/17	TRW	1740	~~[illegible]~~ 247.1		61.3	22.1	1649 ~~[illegible]~~	1674	
C-I(1)-c CT 8/17	RTI		123.3		62.3	22.5	808.0	917.1	
C-I(2) CT 8/17	PEI	BK 322	189.0		61.0	22.0	1266.7	1466.1	
C-I(3) CT 8/17	PEI	BK 328	260.9		60.0	21.7	1772.8	2051.8	
C-I(1)-a CT 8/18	PEI		14.2		54.2	21.5	97.4	112.7	
C-I(1) b CT 8/18	TRW	[illegible]	~~5323~~ 4092		59.5	23.6	2557 ~~[illegible]~~	2596	VALUES [illegible] 8/1/80
C-I(1) c CT 8/18	RTI		4788		61.0	24.2	2917.3	3311.4	
C-I(2) CT 8/18	PEI	BK 323	244.1		57.2	22.7	1585.6	1835.2	
C-I(3) CT 8/18	PEI		439.2		56.0	22.4	2891.1	3346.2	
C-I(1)a CT 8/19	PEI	BK 317	191.3		62.3	28.0	1007.4	1166.0	
C-I(1)b CT 8/19	TRW	173[illegible]	~~[illegible]~~ 281.2		57.2	25.7	1613 ~~[illegible]~~	1636	FT. BK
C-I(1)c CT 8/19	RTI		324.5		62.3	28.0	1708.8	1939.6	
C-I(2) CT 8/19	PEI	BK 324	182.4		62.3	28.0	960.5	1111.7	
C-I(3) CT 8/19	PEI		188.4		60.5	27.2	1022	1182.9	
C-I(1)a CT 8/20	PEI	BK 318	207.0		60.5	25.4	1201.7	1390.9	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 8
Checked By AH Date 11/25/80
Computed By M.S.K. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	Desorption efficiency (D.E.)	Mean sample flow rate, cc/m	Sample volume, l	PPB	Corrected PPB	
C-I(1)b CT 8/20	TRW	1741	~~[illegible]~~ ←	259.6	55.0	23.1	1658 ~~[illegible]~~	1684	
C-I(1)c CT 8/20	RTI	—	324.9		64.1	26.9	1783	2023.8	
C-I(2) CT 8/20	PEI	BK 325	200.8		59.0	24.8	1195	1383.1	
C-I(3) CT 8/20	PEI	BK 331	235.2		62.3	26.2	1325	1533.6	
C-I(1)a CT 8/21	PEI	-	55.4		57.2	28.7	285	329.9	
C-I(1)b CT 8/21	PEI	BK320	52.7		56.4	28.3	275	318.3	
C-I(1)c CT 8/21	RTI		81.8		61.8	31.0	387	439.3	
C-I(2) CT 8/21	PEI		44.5		56.9	28.5	230	266.2	
CI(3) CT 8/21	PEI	BK332	67.1		58.2	29.2	339	392.4	
CI(1)a CT 8/22					58.6	20.0		—	No sample Rpt'd
C-I(1)b CT 8/22	TRW	1744	~~[illegible]~~ ←	159.5	58.2	19.8	1189 ~~[illegible]~~	1207	
C-I(1)c CT 8/22	RTI		186.3		59.5	20.3	1354	1536.9	
C-I(2) CT 8/22	TRW	1730	~~[illegible]~~ ←	150.7	86.0	29.3	759 ~~961~~	771	
CI(3) CT 8/22	TRW	1742	~~[illegible]~~ ←	207.0	57.2	19.5	1567 ~~[illegible]~~	1591	
D-I(1)a CT 8/30	PEI	BK 475	359.9		61.0	30.1	1765	2042.8	
D-I(1)b CT 8/30	TRW	1750	743.3		61.0	30.1	3630	3645	
D-I(1)x CT 8/30	RTI	-	539.4		61.0	30.1	2645	3002.3	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 9
within .2%
Checked By DH Date 10/25/8
Computed By H. B. K. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total μg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
D-I(2)CT 8/30	PEI	BK 482	35.46		61.0	30.1	173.8	201.2	
D-I(3)CT 8/30	PEI	BK 487	45.86		61.0	30.1	224.7	260.1	
D-I(1)aCT 8/31	PEI	BK 476	142.6		86.0	34.5	609.5	705.4	
D-I(1)bCT 8/31	TRW	1772	[illegible]		56.9	22.8	1610.3	1635	
D-I(1)c CT 8/31	RTI	—	283.9		57.8	23.2	1804.3	2048.0	
D-I(2) CT 8/31	PEI	BK 483	48.11		59.5	23.9	296.8	343.5	
D-I(3) CT 8/31					—	—	.	—	No sample, tube fell
D-I(1)a CT 9/1	PEI	BK 477	902.9		58.2	26.4	5042.9	5836.7	
D-I(1)b CT 9/1	TRW	1777	1629.6		61.3	27.8	8643.3	8774	
D-I(1)cCT 9/1	RTI	—	1296.3		58.6	26.5	7212.8	8187.1	
D-I(2) CT 9/1	PEI	BK 484	536.7		58.2	26.4	3008.7	34823	
D-I(3) CT 9/1	PEI	BK 489	37.81		59.0	26.7	208.8	241.7	
D-I(1)aCT 9/2	PEI		452.4		55.5	22.5	2964.7	3431.4	
D-I(1)bCT 9/2	TRW	761	[illegible]		56.4	22.9	4211.0	4275	
D-I(1)cCT 9/2	RTI	—	587.6		59.5	24.2	3580.2	4063.5	
D-I(2) CT 9/2	PEI	BK 485	129.4		50.4	20.5	930.7	10772	
D-I(3)CT 9/2	PEI	BK 490	28.14		46.5	18.9	219.5	254.0	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
Sheet No. 10
Checked By [illegible] Date 11/25/80
Computed By H.B.K Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cm³/m	Sample volume, ℓ	PPB	Corrected PPB	
D-I(1)a CT 9/2	PEI		135.1		56.0	24.3	819.8	948.8	
D-I(1)b CT 9/3	PEI	BK 480	121.8		60.5	26.3	682.9	790.4	
D-I(1)c CT 9/3	RTI	—	199.4		56.0	24.3	1203.9	1366.5	
D-I(2) CT 9/3	PEI	BK 486	41.72		56.0	24.3	253.2	293.1	
D-I(3) CT 9/3	PEI	BK 491	14.69		56.0	24.3	89.1	103.1	
D-I(1)a CT 9/4	PEI		275.1		57.2	27.6	1469.7	1701.1	
D-I(1)b CT 9/4	TRW	[illegible]	[illegible]		56.9	27.5	1783.3	1810	
D-I(1)c CT 9/4	RTI		328.8		55.6	26.9	1602.3	2045.7	
D-I(2) CT 9/4	TRW	[illegible]	135.9		60.5	29.2	686.2	697	
D-I(3) CT 9/4	TRW	[illegible]	[illegible]		60.5	29.2	320.1	325	
D-I(1)a CT 9/5					56.9	12.9		—	No Sample Rept'd
D-I(1)b CT 9/5	TRW	[illegible]	179.5		57.2	13.0	2035.9	2067	
D-I(1)c CT 9/5	RTI		165		60.5	13.7	1775.8	2015.7	
D-I(2) CT 9/5	TRW	[illegible]	[illegible]		59.0	13.4	888.0	902	
D-I(3) CT 9/5	TRW	[illegible]	66.9		57.2	13.0	758.8	770	
D-II(1)a CT 8/30	PEI	BK 492	125.5		86.0	38.4	481.9	557.8	
D-II(1)b CT 8/30	TRW	1702	216.8		58.7	26.2	1220.1	1239	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC Field Sample data

PN
Sheet No. 11
Checked By A H Date 11/25/80
Computed By H.B.F. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, l/m	Sample volume, l	PPB	Corrected PPB	
D-II-(1)-c CT 8/30	RTI		246.4		58.2	26.0	1397.4	1586.2	
D-II (2) CT 8/30	[illegible]	BK 499	120.9		53.6	24.0	742.8	859.7	
D-II (3) CT 8/30	PEI	BK 504	219.8		61.8	27.6	1174.2	1359.0	
D-II (1)a CT 8/31	PEI	BK 493	77.27		55.0	22.1	515.5	596.6	
D-II(1)b CT 8/31	[illegible]	[illegible]	[illegible]		57.2	22.9	821.6	834	
D-II(1)c CT 8/31	RTI		125.9		56.4	22.6	821.9	932.3	
D-II (2) CT 8/31	PEI	BK 500	60.70		52.4	21.0	426.2	493.4	
D-II (3) CT 8/31	PEI	BK 505	101.5		56.0	22.5	665.2	770.0	
D II(1) a CT 9/1	PEI	BK 494	527.6		51.5	22.0	3549.5	4108.2	
D-II(1)b CT 9/1	TRW	17.9	102.5		59.5	25.4	595.0	604	
D-II(1)c CT 9/1	RTI		846.3		56.0	23.9	5221.2	5926.4	
D-II(2) CT 9/1	PEI	BK 501	1353.5		56.0	23.9	8350.2	9665.1	
D-II(3) CT 9/1	PEI	BK 506	687.4		62.3	26.6	3810.4	4325.1	
D-II(1)a CT 9/2	PEI	BK 495	83.25		54.7	22.2	552.9	639.9	
D-II(1)b CT 9/2	[illegible]	17.61	123.0		55.5	22.5	606.1	818	
D-II(1)c CT 9/2	RTI		123.0		58.7	23.8	762.0	864.9	
D-II(2) CT 9/2					55.5	22.5			No Sample Rep't'd

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC Field Sample data

PN
Sheet No. 12
Checked By JKH Date 11/25/80
Computed By H.B.C Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total μg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cm^3/m	Sample volume, ℓ	PPB	Corrected PPB	
D-II (3) CT 9/3	PEI	BK 507	93.75		58.7	23.8	580.8	672.2	
D II (1)a CT 9/3	PEI	BK 496	457.5		49.2	21.4	3152.2	3648.4	
D II (1)b CT 9/3	TRW	1735	600.6		51.2	25.3	3850.0	3707	
D II (1)c CT 9/3	RTI		607		61.3	26.6	3364.7	3819.2	
D-II (2) CT 9/3	PEI	BK 503	17.17		60.5	26.3	96.3	111.4	
D-II (3) CT 9/3	PEI	BK 508	475.3		60.5	26.3	2669.7	3054.1	
D II (1)a CT 9/4	PEI	BK 497	64.72		55.6	26.5	360.1	416.8	
D II (1)b CT 9/4	TRW	[illegible]	93.3		57.2	27.2	503.8	514	
D II (1)c CT 9/4	RTI		82.5		54.7	26.0	467.9	531.1	
D II (2) CT 9/4	TRW	1759	152.6		56.0	26.7	842.7	856	
D II (3) CT 9/4	TRW	1720	93.5		56.0	26.7	516.3	524	
D II (1)a CT 9/5	PEI	BK 498	149.9		60.0	27.1	815.6	944.0	
D II (1)b CT 9/5	TRW	1780	192.6		59.0	26.7	1096.6	1114	
D II (1)c CT 9/5	RTI		171.4		56.4	25.5	991.1	1125.0	
D II (2) CT 9/5	TRW	1782	159.9		52.0	23.5	1003.3	1019	
D II (3) CT 9/5	TRW	1756	232.9		56.0	25.3	1357.3	1578	
E-I (1)a CT 8/30	PEI	BK 520	1530.7		59.0	21.2	10646.2	12322.0	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
Sheet No 13
Checked By AH Date 9/25/80
Computed By H.B.K. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total ug found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, l	PPB	Corrected PPB	
E·I-(1)b CT 8/30	PEI	BK 521	1990.9		61.0	21.9	13404.4	15514.4	
E·I-(1)c CT 8/30	PEI	BK 522	1335.7		42.7	15.3	12872.9	14898.6	
EI (2)c CT 8/30	PEI	BK 541	1411.3		59.0	21.2	9815.8	11362.9	
EI (2)b CT 8/30	TRW	1790	2043.8		53.6	19.2	15695.6	15935	
EI (2)c CT 8/30	RTI		1753		49.2	17.7	14603.3	16575.8	
EI (3)a CT 8/30	PEI	BK 548	2451.0		58.2	20.9	16939.0	19605.3	
EI (3)b CT 8/30	PEI	BK549	914.9		30.8	11.1	12153.3	14066.3	
EI (3)c CT 8/30	PEI	BK550	749.2		56.9	20.4	6860.7	7940.6	
EI (1)a CT 8/31	PEI	BK 523	688.8		58.2	18.3	5849.9	6423.5	
EI (1)b CT 8/31	PEI	BK 524	579.0		59.0	18.5	4614.8	5341.2	
EI (1)c CT 8/31	PEI	BK 525	774.3		45.7	14.3	7983.9	9240.6	
EI (2)c CT 8/31	PEI	BK 542	559.1		58.2	18.3	4500.9	5214.0	
EI (2)b CT 8/31	TRW	1789	872.4		54.7	17.2	7478.8	7592	
EI (2)x CT 8/31	RTI		925.7		46.5	14.6	9348.9	10,11.7	
EI (3)a CT 8/31	PEI	BK551	400.2		55.0	17.3	3440.9	3947.8	
EI (3)b CT 8/31	PEI	BK552	411.6		31.6	9.9	6130.3	7095.2	
EI (3)c CT 8/31	PEI	BK553	441.2		56.4	17.7	3675.4	4253.9	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
Sheet No. 14
Checked By A H Date 11/25/80
Computed By H.B.K Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c³/m	Sample volume, ℓ	PPB	Corrected PPB	
E-I(1)a CT 9/1	PEI	BK 526	1215.2		58.2	23.1	7756.7	8977.7	
E-I(1)b CT 9/1	PEI	BK 527	1240.2		58.2	23.1	7916.3	9162.4	
E-I(1)c CT 9/1	PEI	BK 528	1193.8		38.6	15.3	11504.9	13315.9	
E-I(2)a CT 9/1	PEI	BK543	970.9		56.0	22.2	6448.6	7463.7	
E-I(2)b CT 9/1	TRW	1792	1367.7		50.8	20.2	9983.5	10135	
E-I(2)c CT 9/1	RTI		1410.4		46.0	18.3	11364.1	12899.1	
E-I(3)a CT 9/1	PEI	BK559	855.5		64.1	25.4	4966.2	5747.9	
E-I(3)b CT 9/1	PEI	BK 555	701.4		52.6	12.9	8017.1	9279.0	
E-I(3)c CT 9/1	PEI	BK 556	860.2		62.7	24.9	5093.8	5895.6	
E-I(1)a CT 9/2	PEI	BK 529	1533.7		62.3	29.1	7771.2	8994.9	
E-I(1)b CT 9/2	PEI	BK 530	1717.2		60.5	28.3	8947.0	10355.3	
E-I(1)c CT 9/2	PEI	BK531	2039.0		56.9	26.6	11302.6	13081.7	
E-I(2)a CT 9/2	PEI	BK 544	1244.5		61.8	28.9	6604.6	7644.2	
E-I(2)b CT 9/2	TRW	1791	2226.9		64.7	30.2	10872.7	11038	
E-I(2)c CT 9/2	RTI		2137.5		79.3	37.0	8518.2	9665.8	
E-I(3)a CT 9/2	PEI	BK 557	1505.3		61.0	28.5	7787.9	9013.8	
E-I(3)b CT 9/2	PEI	BK558	1048.6		32.6	15.2	10172.0	11773.1	

CLIENT EMSL /EPA

LOCATION

SUBJECT PERC field sample data

PN

Sheet No. 15

Checked By A H Date 11/25/80

Computed By H.B.K Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total μg found	Desorption efficiency (D.E.)	Mean sample flow rate, c³/m	Sample volume, l	PPB	Corrected PPB	
E-I(3)c CT 9/2	PEI	BK 559	1145.1		59.5	27.8	6073.5	7029.5	
E-I(1)a CT 9/3	PEI	BK 532	5.46		63.2	28.9	27.4	32.3	discard
E-I(1)b CT 9/3	PEI	BK 533	234.9		59.5	27.3	1268.7	1465.4	
E-I(1)c CT 9/3	PEI	BK 534	273.9		56.9	26.1	1597.4	1791.0	
E-I(2)c CT 9/3	PEI	BK 544	1263.7		59.5	27.3	6825.3	7899.6	
E-I(2)b CT 9/3	TRW	1795	530.3		62.3	28.5	2743.6	2785	
E-I(2)c CT 9/3	RTI		518.3		73.5	33.7	2267.7	2574.0	
E-I(3)a CT 9/3	PEI	BK 560	234.6		60.5	27.7	1240.8	1445.4	
E-I(3)b CT 9/3	PEI	BK 561	220.4		83.0	38.0	855.2	989.8	
E-I(3)c CT 9/3	PEI	BK 562	234.0		58.6	26.8	1287.4	1490.0	
E-I(1)a-CT 9/4	PEI	BK 535	1525.1		59.0	27.0	8328.1	96397	
E-I(1)b CT 9/4	PEI	BK 536	1580.9		59.0	27.0	8633.4	9992.4	
E-I(1)c CT 9/4	PEI	BK 537	1255.3		60.5	27.7	6682.0	7733.8	
E-I(2)c CT 9/4	PEI	BK 546	1350.2		59.0	27.0	7373.5	8534.1	
E-I(2)b CT 9/4	TRW	1787	2038.5		62.3	28.5	10546.5	10707	
E-I(2)c CT 9/4	RTI		2149.3		73.5	33.7	9403.9	10674.1	
E-I(3)c CT 9/4	PEI	BK 563	1253.2		58.7	26.9	6869.3	7950.6	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 16
Checked By DH Date 11/25/80
Computed By H.B.K Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
E-I(2)b CT 9/4	PEI	BK 564	1042.0		72.0	33.0	4655.8	5388.7	
E-I(3)c CT 9/4	PEI	BK 565	1236.7		55.6	25.5	7151.0	8276.6	
E-I(1)a CT 9/5	PEI	BK 538	1343.0		63.2	27.3	7253.6	8395.4	
E-I(1)b CT 9/5	PEI	BK 539	1312.4		57.2	24.7	8013.6	9275.0	
E-I(1)c CT 9/5	PEI	BK 540	1679.3		59.5	25.7	9634.7	11151.3	
E-I(2)a CT 9/5	PEI	BK 597	1260.7		59.0	25.5	7341.8	8497.4	
E-I(2)b CT 9/5	TRW	1793	2607.2		61.8	26.7	14398.1	14617	
E-I(2)c CT 9/5	RTI		2087.1		73.8	31.9	9647.0	10950.1	
E-I(3)a CT 9/5	PEI	BK 566	1076.0		56.0	24.2	6556.0	7588.0	
E-I(3)b CT 9/5					85.0	36.7		—	No sample Rcpt'd
E-I(3)c CT 9/5	PEI	BK 568	1032.4		72.0	31.1	4894.7	5665.2	
F-I(1)a CT 8/30	PEI	BK 605	93.87		60.5	17.1	809.4	936.8	
F-I(1)b CT 8/30	PEI	BK 606	90.68		550	15.5	862.6	998.4	
F-I(1)c CT 8/30	RTI		111.9		53.6	15.1	1092.7	1240.3	
F-I(2) CT 8/30					—	—	—	—	Final flow=0; void
F-I(3) CT 8/30	PEI	BK 620	91.49		54.7	15.4	876.0	1013.9	
F-I(1)c CT 8/30	PEI	BK 607	65.3		53.1	14.0	687.7	795.9	

CLIENT EMSL / EPA

LOCATION

SUBJECT PERC field Sample data

PN -

Sheet No. 17

Checked By JH Date 11/25/80

Computed By M.B.K. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
F-I(1)b CT 8/3	PEI	BK 608	63.81		56.0	14.7	640.0	740.7	
F-I(1)c CT 8/31	RTI		83.4		59.0	15.5	793.4	900.6	
F-I(2) CT 8/31	PEI	BK 615	29.44		59.0	15.5	280.1	324.2	
F-I(3) CT 8/31	PEI	BK 621	49.41		59.5	15.6	467.0	540.5	
F-I(1)a CT 9/1	PEI	BK 609	71.22		52.8	20.4	514.8	595.8	
F-I(1)b CT 9/1	TRW	1806	94.6		55.0	21.2	658.0	668	
F-I(1)c CT 9/1	RTI		96.6		60.5	23.4	608.7	690.9	
F-I(2) CT 9/1	PEI	BK616	17.60		59.5	23.0	112.8	130.6	
F-I(3) CT 9/1	PEI	BK 622	76.4		59.5	23.0	489.8	566.9	
F-I(1)a CT 9/2	PEI	BK 610	47.26		60.5	23.4	297.8	344.7	
F-I(1)b CT 9/2	TRW	1801	60.1		60.5	23.4	378.7	384	
F-I(1)c CT 9/2					60.5	23.4	–	–	No Sample Rept'd
F-I(2) CT 9/2	PEI	BK 617	13.45		57.2	22.1	89.7	103.8	
F-I(3) CT 9/2	PEI	BK 623	65.75		56.0	21.7	446.7	517.0	
F-I(1)a CT 9/3	PEI	BK 611	566.8		53.6	29.9	2795.1	3235.1	
F-I(1)b CT 9/3	TRW	1812	843.5		56.0	26.0	4783.6	4856	
F-I(1)c CT 9/3	RTI		787.5		58.2	27.0	4300.6	4881.5	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	Desorption efficiency (D.E.)	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
F-I-(2)CT 9/3	PEI	BK618	156.7		60.5	28.1	823.0	952.5	
F-I-(3)CT 9/3	PEI	BK 624	571.5		60.5	28.1	2998.8	3470.8	
F-I(1)a CT 9/4	PEI	BK612	292.4		52.8	22.8	1691.0	2188.6	
F-I(1)b CT 9/4	PEI	BK613	282.9		50.8	21.9	1904.7	2204.5	
F-I(1)c CT 9/4	RTI		432		56.0	24.1	2643.1	3000.1	
F-I (2) CT 9/4	PEI	BK619	131.7		57.8	24.9	779.9	902.7	
F-I (3) CT 9/4	PEI	BK 625	327.1		56.0	24.1	2001.3	2316.3	
F-I (1)a CT 9/5	TRW	1813	140.1		53.6	21.9	943.3	958	
F-I(1)b CT 9/5	TRW	1809	143.1		52.8	21.6	976.8	992	
F-I(1)c CT 9/5	RTI		1445		56.0	22.9	930.4	1056.1	
F I(2) CT 9/5					56.0	22.9		—	No Sample Rptd
F I(3) CT 9/5	TRW	1802	330.9		53.6	21.9	2227.9	2262	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
A-II-a CT 8/16	PEI	BK162	0.166		223	298	0.082	0.097	
A-II b CT 8/16	PEI	BK 163	0.24		224	299	0.118	0.139	
A-II-c CT 8/16	TRW	1699	0.256		223	298	0.127	0.187	
A-III a CT 8/16	PEI	BK 199	0.302		224	307	0.145	0.171	
A-III b CT 8/16	PEI	BK 174	9.49		222	304	4.60	5.44	
A-III c CT 8/16	PEI	BK 175	8.78		215	295	4.39	5.19	
A-IV a CT 8/16					—	—		—	pump out, No sample
A-IV b CT 8/16					—	—		—	" "
A-IV c CT 8/16					—	—		—	" "
A-V a CT 8/16					232	321		—	No value Reptd
A-V b CT 8/16	PEI	BK200	0.17		223	309	0.081	0.096	
A-V c CT 8/16	PEI	BK 201	0.249		227	314	0.117	0.138	
A-II-a CT 8/17	PEI	BK164	0.260		152	230	0.167	0.197	
A-II-b CT 8/17	TRW	1690	0.667		—	—		—	F&B/waterlogged
A-II-c CT 8/17	RTI		—		—	—		—	N.S waterlogged
A-III a CT 8/17	PEI	BK176	4.17		227	345	1.78	2.10	
A-III b CT 8/17	PEI	BK177	3.65		227	345	1.56	1.84	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c^3/m	Sample volume, ℓ	PPB	Corrected PPB	
A-III-c CT 8/17	PEI	BK 178	3.52		217	330	1.57	1.86	
A-IV-a CT 8/17					—	—		—	pump out, no sample
A-IV b CT 8/17					—	—		—	" "
A-IV c CT 8/17					—	—		—	" "
A-V a CT 8/17	PEI	BK 202	1.15		236	358	0.474	0.56	
A-V b CT 8/17	PEI	BK 203	0.718		217	329	0.322	0.38	
A-V c CT 8/17					—	—		—	waterlogged, No Sample
A-II-a CT 8/18	PEI	BK 165	1.93		222	349	0.604	0.71	
A-II b CT 8/18	TRW	1707	1.877		222	349	0.793	1.17	
A-II c CT 8/18	RTI		0.88		187	294	0.441	0.73	
A-III a CT 8/18	PEI	BK 179	3.00		187	294	1.50	1.77	
A-III b CT 8/18	PEI	BK 180	4.21		213	335	1.85	2.19	
A-III c CT 8/18	PEI	BK 181	1.40		136	214	0.965	1.14	
A-IV a CT 8/18					—	—		—	pump out, no sample
A-IV b CT 8/18					—	—		—	" "
A-IV c CT 8/18					—	—		—	" "
A-V a CT 8/18	PEI	BK 205	3.41		226	356	1.41	1.67	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (Pct.)~~	Mean sample flow rate, c^3/m	Sample volume, ℓ	PPB	Corrected PPB	
A-V-b-CT 8/19	PEI	BK 206	4.64		218	343	1.99	2.35	
A-V-c CT 8/19	PEI	BK 207	1.74		234	368	0.697	0.824	
A-I-a CT 8/19	PEI	BK 166	2.44		217	318	1.13	1.34	
A-II b CT 8/19	PEI	BK 167	2.42		222	326	1.09	1.29	
A-I. c CT 8/19	RTI		2.52		226	331	1.12	1.8[illegible]	
A-III a CT 8/19	PEI	BK 182	47.51		166	243	28.8	34.0	
A-III b CT 8/19	PEI	BK 183	49.25		207	304	24.2	28.6	
A-III c CT 8/19	PEI	BK 180	6.39		125	183	5.15	6.09	
A-IV a CT 8/19	PEI		1.81		185	265	1.01	1.19	
A-IV b CT 8/10					205	293		---	} No values Rep'td
A-IV c CT 8/19					224	320		—	
A V a CT 8/19	PEI		1.56		205	301	0.76	0.90	
A-V b CT 8/19	PEI		2.05		205	301	1.00	1.18	
A-V c CT 8/19	PEI	BK210	2.61		222	326	1.18	1.39	
A-II-a CT 8/20	PEI	BK168	0.63		213	307	0.302	0.357	
A-II-b CT 8/20	TRW	1695	0.933		215	310	0.444	0.655	F&B
A-II c CT 8/20	RTI		0.24		203	392	0.903	1.502	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
A-III-a CT 8/20	PEI	BK 185	22.00		125	183	17.7	20.9	
A-III b CT 8/20	PEI	BK 186	16.89		180	264	9.43	11.1	
A-III c CT 8/20					125	183		–	No Sample Rec't'd
A-IV a CT 8/20	PEI	BK 193	3.19		140	199	2.36	2.79	
A-IV b-CT 8/20	TRW	1689	7.030		205	291	3.56	5.25	
A-IV c CT 8/20	RTI		9.17		207	294	4.60	7.65	
A-V a CT 8/20	PEI	BK 211	0.89		205	292	0.45	0.53	
A-V b CT 8/20	PEI	BK 212	0.53		203	289	0.27	0.32	
A-V c CT 8/20					223	317			No Sample Rec't'd
A-II a CT 8/21	PEI	BK 169	1.40		215	289	0.71	0.84	
A-II b CT 8/21	PEI	BK 170	1.74		223	300	0.86	1.02	
A-II c CT 8/21	RTI		5.57		213	287	2.86	4.76	
A-III a CT 8/21	PEI	BK 188	5.43		178	241	3.32	3.92	
A-III b CT 8/21	PEI	BK189	8.22		200	271	4.47	5.28	
A-III c CT 8/21	PEI	BK190	6.87		140	190	5.33	6.30	
A-IV a CT 8/21	PEI	BK 194	7.16		167	227	4.65	5.50	
A-IV b CT 8/21	PEI	BK 195	4.85		212	288	2.47	2.92	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c³/m	Sample volume, ℓ	PPB	Corrected PPB	
A-IV-c CT 8/21	PEI	BK196	7.23		212	288	3.70	4.37	
A-V-a CT 8/21	PEI	BK 214	2.34		215	299	1.15	1.36	
A V b CT 8/21	PEI	BK 215	2.38		213	297	1.18	1.39	
A-V c CT 8/21	RTI		2.6		213	297	1.29	2.15	
A-II-a CT 8/22	PEI	BK171	0.43		217	259	0.24	0.28	
A-II b CT 8/22	PEI	BK172	0.857		222	266	0.48	0.57	
A-II c CT 8/22	RTI		0.64		215	257	0.37	0.62	
A III a CT 8/22	PEI	BK 191	13.81		168	249	8.18	9.67	
A II b CT 8/22	PEI	BK 192	13.47		197	292	6.80	8.04	
A II c CT 8/22					—	—			tube broken; no sample
A IV a CT 8/22	PEI	BK 197	6.99		163	242	4.26	5.04	
A IV b CT 8/22	PEI	BK 198	8.36		215	320	3.85	4.55	
A IV c CT 8/22	RTI		11.72		205	305	5.66	9.42	
A-V a CT 8/22	PEI	BK 216	0.92		213	317	0.43	0.51	
A V b CT 8/22	PEI	BK 217	0.85		208	309	0.40	0.47	
A-V c CT 8/22	PEI	BK218	1.41		222	330	0.63	0.74	
B-II CT 8/16	PEI	290	1.20		217	618	0.29	0.34	2 day sample

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, l/m	Sample volume, l	PPB	Corrected PPB	
B-III CT 8/16	PEI	BK294	2.7		227	302	1.32	1.56	
B IV CT 8/16	PEI	BK299	0.5		222	296	0.25	0.30	
B Va CT 8/16	PEI	BK324	0.13		237	306	0.063	0.074	
B-Vb CT 8/16	PEI	BK305	0.29		237	306	0.14	0.17	
B-Vc CT 8/16					—	—			Valve bad, no sample
B-II CT 8/17	See	B-II-CT	8/17		—	—		—	See B-II-CT 8/16
B-III CT 8/17	PEI	B295.	Sample lost		—	—			waterlogged, no sample
B IV CT 8/17	PEI	Bk300	11.18		—	—			" "
B-Va CT 8/17					—	—			" "
B-Vb CT 8/17					—	—			" "
B-Vc CT 8/17					—	—			" "
B-II CT 8/18	PEI	B291	1.14		195	262	0.64	0.76	
B-III CT 8/18	PEI	B296	Sample Lost		—	—		—	waterlogged, no sample
B-IV CT 8/18	PEI	B301	4.92		223	302	2.40	2.84	
B-Va CT 8/18	PEI	B308	3.00		223	297	1.99	1.76	
B Vb CT 8/18	PEI	B309	1.6		223	297	0.79	0.93	
B-Vc CT 8/18					—	—			valve bad, no sample

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total ug found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
B-II CT 8/19	PEI	292	3.66		240	353	1.53	1.81	
B-III CT 8/19					208	305			
B-IV CT 8/19	PEI	302	1.82		225	330	0.81	0.96	
B-Va CT 8/19	PEI	BK 310	3.3		212	311	1.56	1.84	
B-Vb CT 8/19	PEI	BK 311	3.63		224 ✓	328	1.63	1.93	
B-Vc CT 8/19					—	—			Valve bad, no sample
B-II-CT 8/20	PEI	293	4.23		187	264	2.36	2.79	
B-III CT 8/20	PEI	BK 298	2.95		171	241	1.80	2.13	
B-IV CT 8/20	PEI	303	1.64		205	290	0.83	0.98	
B-Va CT 8/20	PEI	312	0.57		195	275	0.30	0.35	
B-Vb CT 8/20	PEI	BK 313	0.7		205	289	0.36	0.43	
B-Vc CT 8/20					—	—			valve bad, no sample
B-II-CT 8/21	TRW	1725	9.485		197	318	4.40	6.49	
B-III-CT 8/21	TRW	1722	8.790		188	304 ✓	4.26	6.28	
B-IV-CT 8/21	TRW	1730	2.548		213	343	1.09	1.61	
B-Va CT 8/21	TRW	1731	1.169		215	345	0.50	0.74	
B-Vb CT 8/2	TRW	1717	1.706		223	358	0.70	1.03	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	Desorption efficiency (D.E.)	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
B-V-c CT 8/21	TRW	1726	2.410		208	333	1.07	1.58	
B-II-CT 8/22	TRW	1723	1.257		212	272	0.68	1.00	
B-III CT 8/22	TRW	1719	1.719		192	252	1.00	1.47	
B-IV CT 8/22	TRW	1732	0.787		224	301	0.38	0.56	
B-V$_a$ CT 8/22	TRW	1728	0.635		208	262	0.36	0.53	
B-V$_b$ CT 8/22	TRW	1718	0.637		223	281	0.33	0.49	
B-V$_c$ CT 8/22	TRW	1721	0.472		195	246	0.28	0.41	
C-II CT 8/16					–	–			Power off, no samp's
C-III CT 8/16					–	–			" "
C-IV CT 8/16					–	–			" "
C-V$_a$ CT 8/16	PEI	BK348	1.87		213	274.8	1.00	1.18	
C-V$_b$ CT 8/16	PEI	BK349	1.95		226	291.5	0.99	1.17	
C-V$_c$ CT 8/16	RTI	–	4.52		222	286.4	2.53	3.88	
C-II CT 8/17	PEI		10.4		177	274	5.60	6.62	
C-III CT 8/17					–	–			Power off, no samp's
C-IV CT 8/17					–	–			" " " "
C-V$_a$ CT 8/17	PEI	BK 350	0.77		227	351	0.32	0.38	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, l	PPB	Corrected PPB	
C-V b CT 8/17	PE I	BK351	1.5		227	351	0.63	0.74	
C-V c CT 8/17	RTI		—		—	—			water-logged, no sample
C-II CT 8/18	PE I	BK224	2.69		223	262	1.51	1.78	
C-III CT 8/18					—	—			final flow=0, no sample
C-IV CT 8/18	PE I	BK344	2.15		205	244	1.30	1.54	
C-V a CT 8/18	PE I	BK352	0.9		224	262	0.51	0.60	
C-V b CT 8/18					224	262			No Value Rept'd
C-V c CT 8/18	RTI		0.0		224	262	0.0	0	
C-II CT 8/19	PE I	BK335	23.6		226	321	10.8	12.8	
C-III CT 8/19	PE I	BK340	2.96		197	287	1.52	1.80	
C-IV CT 8/19	PE I	BK345	57.8		213	311	27.9	32.4	
C-V a CT 8/19					190	278			No Value Rept'd
C-V b CT 8/19	PE I		1.0		208	305	0.48	0.57	
C-V c CT 8/19	RTI		0.4		185	271	0.22	0.37	
C-II CT 8/20	PE I	BK336	2.5		215	324	1.14	1.35	
C-III CT 8/20	PE I	BK341	2.46		148	212	1.71	2.02	
C-IV CT 8/20	PE I	BK346	6.48		197	281	3.40	4.02	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
C-V-a CT 8/20	PEI	BK 354	0.65		190	286	0.34	0.40	
C-V b CT 8/20					190	286			No Sample Rec'd
C-V c CT 8/20	RTI		0.0		158	238	0.0	0	
C-II - CT 8/21	PEI	BK 337	2.4		217	336	1.05	1.24	
C-III CT 8/21	PEI	BK 342	18.9		177	308	9.05	10.70	
C-IV CT 8/21	PEI	BK 347	8.2		205	358	3.38	4.00	
C-V a CT 8/21	PEI		2.9		187	326	1.31	1.55	
C-V b CT 8/21					195	340			No Sample Rec'd
C-V c CT 8/21	RTI		2.92		188	328	1.31	2.18	
C-II CT 8/22	TRW	1734	3.000		207	243	1.82	2.68	
C-III CT 8/22	TRW	1743	0.294		200	122	0.36	0.53	
C-IV CT 8/22	TRW	1739	0.614		205	244	0.37	0.55	
C-V a CT 8/22	TRW	1745	0.756		182	214	0.52	0.77	
C-V b CT 8/22					208	244			No Sample Rec'd
C-V c CT 8/22	RTI		1.08		190	223	0.71	1.18	
D-III CT 8/30	PEI	5K509	0.572		222	304	0.71	0.84	
D-IV a CT 8/30	PEI	BK 514	1.76		226	312	0.83	0.98	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cm^3/m	Sample volume, l	PPB	Corrected PPB	
D IVb CT 8/30	TRW	1776	1.834		223	308	0.88	1.30	
D-IV c CT 8/30	RTI		1.70		212	292	0.86	1.43	
D-V-CT 8/30	TRW	1773	2.582		226	309	1.23	1.81	
D-III CT 8/31	PE I		0.9		208	300	0.44	0.52	
D-IVa CT 8/31	TRW	1763	0.878		213	308	0.42	0.62	
D-IVb CT 8/31	TRW	1765	9.021		224	324	4.10	6.05	
D-IV c CT 8/31	RTI		13.5		215	311	6.40	10.65	
D-V CT 8/31					226	331			No Sample Rec'd
D-II CT 9/1	PE I	BX 51[illegible]	3.36		227	351	1.41	1.67	
D-IVa CT 9/1	PE I	BK516	10.22		230	353	4.27	5.05	
D IVb CT 9/1	TRW	1748	13.00		226	347	5.52	8.14	
D-IV c CT 9/1	RTI		12.0		222	341	5.19	8.64	
D-V CT 9/1	TRW	1751	1.242		217	327	0.56	0.83	
D-III CT 9/2	PE I		4.1		190	266	2.27	2.68	
D-IVa CT 9/2	PE I		10.5		212	296	5.23	6.18	
D-IVb CT 9/2	TRW	1754	12.42		212	296	6.19	9.13	
D-IV c CT 9/2	RTI		9.30		177	247	5.55	9.23	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c^3/m	Sample volume, ℓ	PPB	Corrected PPB	
D-V CT 9/2	TRW	1771	1.435		190	265	0.80	1.18	
D-III-CT 9/3	PEI	BK 513	7.42		182	256	4.27	5.05	
D-IVa CT 9/3	PEI	BK 518	3.71		208	293	1.87	2.21	
D-IVb CT 9/3	TRW	1753	3.907		213	300	1.92	2.83	
D-IVc CT 9/3	RTI	—	3.16		208	293	1.59	2.65	
D-V CT 9/3	TRW	1775	1.896		213	300	0.93	1.37	
D-III-CT 9/4	TRW	1757	0.809		215	308	0.39	0.58	
D-IVa CT 9/4	PEI	BK 519	3.32		227	326	1.50	1.77	
D-IVb CT 9/4	TRW	1778	3.284		226	325	1.49	2.20	
D-IVc CT 9/4	RTI		2.66		212	304	1.29	2.15	
D-V CT 9/4	TRW	1774	2.66		222	320	1.22	1.80	
D-III CT 9/5					182	262			sample void *
D-IVa CT 9/5	TRW	1758	3.736		187	268	2.06	3.04	
D-IVb CT 9/5	TRW	1749	3.134		177	254	1.82	2.68	
D-IVc CT 9/5	RTI	—	2.8		158	227	1.82	3.03	
D-V CT 9/5	TRW	1764	2.184		188	269	1.20	1.77	
E-IIa CT 8/30					—	—			power off, no sample

* "E III" apparently mislabeled "D III": Void E III & D III this date

CLIENT EMSL /EPA
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Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
E-II b CT 8/30					—	—			power off, no sample
E-II c CT 8/30					—	—			" "
E-III a CT 8/30	PEI	BK 574	1.08		224	294	0.54	0.64	
E-I b CT 8/30	PEI	BK 575	0.663		230	291	0.34	0.40	
E-I c CT 8/30	PEI	BK 576	0.79		234	307	0.38	0.45	
E-IV a CT 8/30	PEI	BK 592	0.264		230	298	0.13	0.15	
E-IV b CT 8/30	TRW	1785	0.231		222	288	0.12	0.18	
E-IV c CT 8/30	RTI		0.10		234	303	0.049	0.082	
E-II a CT 8/31					—	—			power off, no sample
E-I b CT 8/31					—	—			" "
E-I c CT 8/31					—	—			" "
E-III a CT 8/31	PEI	BK 577	0.09		224	330	0.040	0.047	
E-I b CT 8/31	PEI	BK 578	0.10		222	328	0.045	0.053	
E-I c CT 8/31	PEI	BK 579	0.827		207	305	0.40	0.47	
E-IV a CT 8/31	PEI	BK 593	0.439		230	341	0.20	0.24	
E-IV b CT 8/31	TRW	1796	0.353		230	341	0.15	0.22	
E-IV c CT 8/31	RTI	—	0.26		234	347	0.11	0.18	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
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Checked By OH Date 11/25/80
Computed By H.B.K. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total ug found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, l/m	Sample volume, l	PPB	Corrected PPB	
E-II-a CT 9/1	-	-	—		—	—			N.S. Power off
E-II b CT 9/1	-	—	-	—	—	-			N.S. Power off
E-II c CT 9/1	—	—	-	—	—	—			N.S. Power off
E-III a CT 9/1	PEI	BK 580	0.550		224	304	0.27	0.32	
E-III b CT 9/1	PEI	BK 581	0.02		226	306	0.0096	0.0113	
E-III c CT 9/1	PEI	BK 582	0.557		212	287	0.28	0.33	
E-IV a CT 9/1	PEI	BK 584	0.226		230	311	0.14	0.17	
E-IV b CT 9/1	PEI	BK 595	0.316		230	311	0.15	0.18	
E-IV c CT 9/1	TRW	1786	0.261		230	311	0.12	0.18	
E-II-a CT 9/2	PEI	BK 569	3.45		133	186	2.73	3.23	
E-II-b CT 9/2	TRW	1798	3.746		166	232	2.38	3.51	
E-II c CT 9/2	RTI		3.26		142	198	2.43	4.04	
E-III a CT 9/2	-				192	280	—		No Sample Rec'd
E-III b CT 9/2	PEI	BK 583	15.49		178	259	8.82	10.43	
E-III c CT 9/2	PEI	BK 585	16.145		195	284	8.38	9.91	
E-IV c CT 9/2	PEI	BK 596	2.196		227	331	0.98	1.16	
E-IV b CT 9/2	TRW	1794	1.885		215	314	0.88	1.30	

CLIENT EMSL /EPA
LOCATION
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Checked By SH Date 11/25/80
Computed By H.B.K. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c³/m	Sample volume, ℓ	PPB	Corrected PPB	
E-IV-c CT 9/2	TRW	1783	1,964		227	327	0.88	1.30	
E-II-a CT 9/3	PEI	BK 570	3.73		195	295	1.86	2.20	
E-II b CT 9/3	TRW	1784	3,801		190	288	1.95	2.58	
E-II c CT 9/3	RTI		3.20		194	294	1.60	2.66	
E-III a CT 9/3	PEI	BK 586	5.18		185	281	2.72	3.22	
E-III b CT 9/3	PEI	BK 587	5.51		188	285	2.85	3.40	
E-III c CT 9/3	PEI	BK 588	5.77		194	295	2.88	3.40	
E-IV a CT 9/3	PEI	BK 597	1.10		226	346	0.72	0.85	
E-IV b CT 9/3	PEI	BK 598	2.349		230	352	0.98	1.16	
E-IV c CT 9/3	TRW	1788	2.357		226	346	1.00	1.48	
E-II-a CT 9/4	PEI	BK 571	4.29		224	242	2.61	3.08	
E-II-b CT 9/4	TRW	1797	0,676		213	231	0.43	0.63	
E II c CT 9/4	RTI		0.76		238	258	0.43	0.71	
E III a CT 9/4	PEI	BK 589	1.02		—	—			waterlogged, sample void
E III b CT 9/4	PEI	BK 590	2.28		212	305	1.10	1.30	
E III c CT 9/4	PEI	BK 591	2.26		208	299	1.11	1.31	
E IV a CT 9/4	PEI	BK 599	2.699		223	319	1.25	1.48	

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

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Checked By JH Date 11/25/80
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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cm^3/m	Sample volume, ℓ	PPB	Corrected PPB	
E-IV-b CT 9/4	PEI	BK 600	3.31		268	384	1.27	1.50	
E-IV c CT 9/4	PEI	BK 601	2.87		238	341	1.24	1.47	
E-II-a CT 9/5	PEI	BK 572	1.48		148	209	1.04	1.23	
E-II b CT 9/5	PEI	BK 573	1.148		148	209	0.81	0.96	
E-II c CT 9/5	RTI	—	1.48		180	255	0.86	1.43	
E-II a CT 9/5					164	232			see note, D-III 9/5
E II b CT 9/5					163	230			" "
E-II c CT 9/5					175	247			" "
E-IV a CT 9/5	PEI	BK 602	1.48		213	306	0.71	0.84	
E-IV b CT 9/5	PEI	BK603	1.59		213	306	0.77	0.91	
E-IV c CT 9/5	PEI	BK604	1.67		224	321	0.77	0.91	
F-II a-CT 8/30	PEI	BK626	0.830		215	274	0.95	0.53	
F-II b CT 8/30	TRW	1807	1.000		217	277	0.63	0.78	
F-II c CT 8/31	RTI	—	0.94		226	288	0.48	0.80	
F-III CT 8/31	PEI	BK 634	0.37		213	271	0.20	0.24	
F-IV CT 8/31	PEI	BK639	0.779		224	285	0.40	0.47	
F-II-a CT 8/31	PEI	BK627	0.51		224	330	0.23	0.27	

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Date 11/25/80
Computed By H.B.K.
Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total μg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c^3/m	Sample volume, ℓ	PPB	Corrected PPB	
F-II-b CT 8/21	PEI	BK 628	0.388		213	314	0.18	0.21	
F-II c CT 8/31	RTI	–	0.50		222	328	0.22	0.37	
F-III CT 8/31	PEI	BK 635	0.59		230	338	0.26	0.31	
F-IV CT 8/31	PEI	BK 640	0.386		212	312	0.18	0.21	
F-II c CT 9/1	PEI	BK 629	0.464		208	282	0.24	0.28	
F-II b CT 9/1	TRW	1810	0.532		212	288	0.27	0.40	
F-II c CT 9/1	RTI	–	0.42		213	289	0.21	0.35	
F-III CT 9/1	PEI	BK 636	106		230	320	0.49	0.58	
F-IV CT 9/1	PEI	BK 641	0.636		224	311	0.31	0.37	
F-II c CT 9/2	PEI	BK 360	1.92		168	300	0.94	1.11	
F-II b CT 9/2	PEI	BK 631	1.93		177	258	1.10	1.30	
F-II c CT 9/2	RTI	—	2.60		195	284	1.35	2.25	
F-II CT 9/2	PEI	BK 637	1.54		230	306	0.74	0.87	
F-IV CT 9/2	PEI	BK 642	1.15		195	285	0.59	0.70	
F-II c CT 9/3	PEI	BK 632	5.38		177	258	3.07	3.63	
F-II b CT 9/3	TRW	1805	5.818		182	266	3.22	4.75	
F-II c CT 9/3	RTI	–	5.36		195	285	2.77	4.61	

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LOCATION
SUBJECT PERC field Sample data

PN
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Checked By [illegible] Date 11/25/80
Computed By H.B.K. Date 11-25-80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
F-III-CT 9/3	PEI	BK 638	1.25		222	361	0.51	0.60	
F-IV CT 9/3	PEI	BK 643	5.30		177	269	2.90	3.43	
F-IIa CT 9/4					230	157			power off part time
F-IIb CT 9/4	TRW	1808	0.646		238	162	0.59	0.87	"
F-IIc CT 9/4	RTI		0.48		238	162	0.44	0.73	" "
F-III CT 9/4					230	326			No Sample Rec'd
F-IV CT 9/4	PEI	BK644	18.4		215	310	8.75	10.34	
F-IIa CT 9/5	TRW	1799	1.703		140	206	1.22	1.80	
F-IIb CT 9/5	TRW	1811	0.532		185	272	0.29	0.43	
F IIc CT 9/5	RTI		2.20		190	279	1.16	1.93	
F-III CT 9/5	TRW	1803	14.212		224	322	6.51	9.60	
F IV CT 9/5	TRW	1804	1.372		236	343	0.59	0.87	

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	Desorption efficiency (D.E.)	Mean sample flow rate, c^3/m	Sample volume, l	PPB	Corrected PPB	
A-I-(1)a 3M 8/16	PEI	BJ999	2.84		28.9	13.9	30.2		(109)
A-I-(1)b 3M 8/16	PEI	BK001	2.86				30.4		(109)
A-I(1)c 3M 8/16	TRW	1643	24.3				258		-
A-I(2)a 3M 8/16									No sample Rpt'd
A-I(2)b 3M 8/16	PEI	BK015	3.18				33.8		(122)
A-I(2)c 3M 8/16	TRW	1634	14.3				152		
A-I(3)c 3M 8/16	PEI	BK027	2.06				21.9		(7[illegible]
A-I(3)b 3M 8/16	PEI	BK027	3.93			↓	41.7		(15[illegible])
A-I(3)c 3M 8/16	TRW	1630	8.5				90.3		[illegible]
A-I(1)a 3M 8/17	PEI	BK002	3.35			11.7	42.3		[illegible]
A-I(1)b 3M 8/17	PEI	BK003	3.27				41.2		-
A-I(1)c 3M 8/17	PEI	BK004	2.42				30.5		1
A-I(2)a 3M 8/17	PEI	BK016	3.76				47.4		
A-I(2)b 3M 8/17	PEI	BK017	5.41				68.2		
A-I(2)c 3M 8/17	TRW	1644	24.5				309		
A-I(3)a 3M 8/17	PEI	BK028	1.32				16.7		
A-I(3)b 3M 8/17	PEI	BK029	1.24		↓	↓	15.6		

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SUBJECT PERC field sample data

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Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, L/m	Sample volume, L	PPB	Corrected PPB	
A-I(3)c 3M 8/17	TRW	1631	20.4		28.9	11.7	257		
A-I(1)a 3M 8/18	PEI	BK005	8.34			14.7	83.7		
A-I(1)b 3M 8/18	PEI	BK006	2.30				23.1		
A-I(1)c 3M 8/18	RTI	—	12.55				126		
A-I(2)a 3M 8/18	PEI	BK018	7.23				72.6		
A-I(2)b 3M 8/18	PEI	BK019	5.20				52.2		
A-I(2)c 3M 8/18	TRW	1641	19.1				192		
A-I(3)a 3M 8/18	PEI	BK030	3.23				32.4		
A-I(3)b 3M 8/18	PEI	BK031	8.50				85.3		
A-I(3)c 3M 8/18	RTI	—	14.02			↓	141		
A-I(1)a 3M 8/19	PEI	BK007	3.83			10.0	56.5		
A-I(1)b 3M 8/19	PEI	BK008	3.18				46.9		
A-I(1)c 3M 8/19	PEI	BK009	2.64				39.0		
A-I(2)a 3M 8/19	PEI	BK020	4.46				65.8		
A-I(2)b 3M 8/19	PEI	BK021	4.22				62.3		
A-I(2)c 3M 8/19	TRW	1635	26.1				385		
A-I(3)a 3M 8/19	PEI	BK032	3.82		↓	↓	56.4		

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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total ug found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cm^3/m	Sample volume, l	PPB	Corrected PPB	
A-I(3)b 3M 8/20	PEI	BK033	1.39		28.9	10.0	20.5		
A-I(3)c 3M 8/20	TRW	1632	28.2			↓	416		
A-I(1) a 3M 8/20	PEI	BK010	2.03			9.4	31.9		
A-I(1) b 3M 8/20	PEI	BK011	3.35				52.6		
A-I(1) c 3M 8/20	RTI	–	11.89				187		
A-I(2) a 3M 8/20	PEI	BK022	1.83				28.7		
A-I(2) b 3M 8/20	PEI	BK023	1.59				25.0		
A-I(2)c 3M 8/20	TRW	1629	25.5				400		
A-I(3) a 3M 8/20	PEI	BK034	6.01				94.4		
A-I(3)b 3M 8/20	PEI	BK035	6.04				94.8		
A-I(3)c 3M 8/20	PEI	BK036	6.11			↓	95.9		
A-I(4) a 3M 8/21	TRW	1633	26.3			11.7	332		
A-I(1) b 3M 8/21	TRW	1625	26.8				338		
A-I(1) c 3M 8/21	PEI	BK012	5.58				87.6		
A-I(2) a 3M 8/21	TRW	1626	25.1				317		
A-I(2) b 3M 8/21	TRW	1640	22.3				281		
A-I(2) c 3M 8/21	RTI	–	11.38		↓	↓	144		

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Checked By H.B.K Date 11-25-80
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Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	Desorption efficiency (Def.)	Mean sample flow rate, c³/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I-(3)a 3M 8/21	TRW	1628	25.4		28.9	11.7	320		
A-I(3)b 3M 8/21	TRW	1645	24.0		↓	↓	303		
A-I(3)c 3M 8/21	RTI	-	5.71		↓	↓	72.0		
A-I-(1)a 3M 8/22	TRW	1636	30.0		↓	11.9	372		
A-I(1)b 3M 8/22	TRW	1637	20.1		↓	↓	249		
A-I(1)c 3M 8/22	PEI	BK013	5.28		↓	↓	65.5		
A-I(2)a 3M 8/22	PEI	BK029	5.70		↓	↓	70.7		
A-I(2)b 3M 8/22	PEI	BK025	5.73		↓	↓	71.1		
A-I(2)c 3M 8/22	TRW	1638	30.4		↓	↓	377		
A-I-(3)a 3M 8/22	TRW	1639	33.5		↓	↓	415		
A-I(3)b 3M 8/22	TRW	1627	27.7		↓	↓	344		
A-I(3)c 3M 8/22	TRW	1642	31.0		↓	↓	384		
E-I(1)a 3M 8/30	PEI	BK057	548.1		↓	11.7	6914		
E-I(1)b 3M 8/30	PEI	BK038	517.5		↓	↓	6528		
E-I(1)c 3M 8/30	PEI	BK037	524.5		↓	↓	6616		
E I(2)a 3M 8/30	PEI	BK051	476.0		↓	↓	6004		
E-I(2)b 3M 8/30	PEI	BK052	616.9		↓	↓	7782		

CLIENT EMSL /EPA
LOCATION
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PN
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Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
E-I(2)c 3M 8/30	RTI	-	528.97		28.9	11.1	6673		
E-I(3)a 3M 8/30	PEI	BK066	239.5		│	│	2958		
E-I(3)b 3M 8/3	PEI	BK067	389.7		│	│	4853		
E-I(3)c 3M 8/3	TRW	1683	477.8		│	↓	6027		
E-I(1)a 3M 8/31	PEI	BK040	216.2		│	9.2	3468		
E-I(1)b 3M 8/31	PEI	BK041	224.2		│	│	3597		
E-I(1)c 3M 8/31	RTI	—	332.54		│	│	5335		
E-I(2)a 3M 8/31	PEI	BK053	207.9		│	│	3335		GC/MS= 237.1 µg
E-I(2)b 3M 8/31	PEI	BK054	216.3		│	│	3470		
E-I(2)c 3M 8/31	RTI	—	282.47		│	│	4531		
E-I(3)a 3M 8/31	PEI	BK068	170.5		│	│	2735		
E-I(3)b 3M 8/31	PEI	BK069	137.8		│	│	2211		
E-I(3)c 3M 8/31	PEI	BK070	172.0		│	↓	2759		GC/MS & FID GC/MS= 171.4 µg
E-I(1)a 3M 9/1	PEI	BK092	383.8		│	11.4	4969		
E-I(1)b 3M 9/1	PEI	BK043	411.3		│	│	5325		
E-I(1)c 3M 9/1	TRW TRW	1687 L-1688	417.2 534.1		│	│	5407 6915		~~VOID~~ TWO SAMPLES REPORTED
E-I(2)a 3M 9/1	PEI	BK055	335.7		↓	↓	4346		

CLIENT EMSL /EPA

LOCATION

SUBJECT PERC field Sample data

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Sheet No. 12

Checked By M.S.F Date 11-25-80

Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	Desorption efficiency (D.E.)	Mean sample flow rate, l/m	Sample volume, l	PPB	Corrected PPB	
E-I(2)b 3M 9/1	PEI	BK056	569.5		28.9	11.4	7373		
E-I(2)c 3M 9/1	TRW	1681	468.8		↓	↓	6069		
E-I(3)a 3M 9/1	PEI	BK087	187.5		↓	↓	2427		
E-I(3)b 3M 9/1	PEI	BK088	223.7		↓	↓	2896		
E-I(3)c 3M 9/1					↓	↓			No Sample Rpt'd
E-I(1)a 3M 9/2	PEI	BK044	519.8		↓	13.9	5519		
E-I(1)b 3M 9/2	PEI	BK045	454.6		↓	↓	4827		
E-I(1)c 3M 9/2	TRW	1682	644.2		↓	↓	6840		
E-I(2)a 3M 9/2	PEI	BK057	576.2		↓	↓	6118		
E-I(2)b 3M 9/2	PEI	BK058	594.1		↓	↓	6308		
E-I(2)c 3M 9/2	PEI	BK059	594.1		↓	↓	6308		
E-I(3)a 3M 9/2	PEI	BK071	566.7		↓	↓	6017		
E-I(3)b 3M 9/2	PEI	BK072	328.4		↓	↓	3487		
E-I(3)c 3M 9/2	TRW	1672	665.3		↓	↓	7064		
E-I(1)a 3M 9/3	PEI	BK046	64.97		↓	13.4	716		
E-I(1)b 3M 9/3	PEI	BK047	75.01		↓	↓	826		GC/MS = 77.54 µg
E-I(1)c 3M 9/3	TRW	1673	105.7		↓	↓	1164		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC Field Sample data

PN
Sheet No. 43
Checked By H.B.F. Date 11-25-80
Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, ℓ/m	Sample volume, ℓ	PPB	Corrected PPB	
E-I(2)a 3M 9/3	PEI	BK060	136.7		28.9	13.4	1506		
E-I(2)b 3M 9/3	PEI	BK061	116.4		↓	↓	1282		
E-I(2)c 3M 9/3	PEI	BK062	138.1		↓	↓	1521		
E-I(3)a 3M 9/3	PEI	BK073	79.46		↓	↓	875		
E-I(3)b 3M 9/3	PEI	BK074	82.20		↓	↓	905		GC/MS = 80.14 ng.
E-I(3)c 3M 9/3	TRW	1676	127.5		↓		1404		
E-I(1)a 3M 9/4	PEI	BK048	548.1		↓	13.6	5948		
E-I(1)b 3M 9/4	PEI	BK049	438.8		↓	↓	4762		
E-I(1)c 3M 9/4	PEI	BK050	496.8		↓	↓	5391		
E-I(2)a 3M 9/4	PEI	BK063	552.3		↓	↓	5994		
E-I(2)b 3M 9/4	PEI	BK064	318.3		↓	↓	3454		
E-I(2)c 3M 9/4	PEI	BK065	426.1		↓	↓	4624		
E-I(3)a 3M 9/4	PEI	BK075	402.7		↓	↓	4370		
E-I(3)b 3M 9/4	PEI	BK076	422.8		↓	↓	4588		
E-I(3)c 3M 9/4	RTI	—	603.39		↓	↓	6548		
E-I(1)a 3M 9/5	TRW	1674	987.1		↓	12.9	11293		
E-I(1)b 3M 9/5	TRW	1680	632.3		↓	↓	7254		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 47
Checked By H.B.K. Date 11-25-80
Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, l/m	Sample volume, l	PPB	Corrected PPB	
E-I(1)c 3M 9/5	TRW	1678	643.4		28.9	12.9	7361		
E-I(2)a 3M 9/5	TRW	1686	601.9		↓	↓	6886		
E-I(2)b 3M 9/5	TRW	1679	481.2		↓	↓	5513		
E-I(2)c 3M 9/5	TRW	1685	587.8		↓	↓	6718		
E-I(3)a 3M 9/5	TRW	1671	316.5		↓	↓	3621		
E-I(3)b 3M 9/5	TRW	1675	484.4		↓	↓	5542		
E-I(3)c 3M 9/5	TRW	1677	512.4		↓	↓	5862		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 95
Checked By H.B.K. Date 11-25-80
Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cm³/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I(1)a DP 8/16	PEI	BJ 931	11.00		70.8	34.0	47.7		
A-I(1)b DP 8/16	PEI	BJ 932	22.53				97.8		
A-I(1)c DP 8/16	RTI	–	15.95				69.2		
A-I(2)a DP 8/16	PEI	BJ 942	8.09				35.1		
A-I(2)b DP 8/16	PEI	BJ 943	8.27				35.9		
A-I(2)c DP 8/16	TRW	1609	3.7				16.1		
A-I(3)a DP 8/16	PEI	BJ 953	10.31				44.8		
A-I(3)b DP 8/16	PEI	BJ 954	10.95				47.5		
A-I(3)c DP 8/16	TRW	1610	13.6			↓	59.0		
A-I(1)a DP 8/17	PEI	BJ 933	8.87			28.7	45.6		
A-I(1)b DP 8/17	PEI	BJ 934	8.96				46.1		
A-I(1)c DP 8/17	PEI	BJ 935	9.33				48.0		
A-I(2)a DP 8/17	PEI	BJ 944	12.96				66.6		
A-I(2)b DP 8/17	PEI	BJ 945	14.46				74.4		
A-I(2)c DP 8/17	TRW	1605	22.7				117		
A-I(3)a DP 8/17	PEI	BJ 955	5.28				27.2		
A-I(3)b DP 8/17	PEI	BJ 956	5.47		↓	↓	28.1		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 46
Checked By H.B.K. Date 11-25-80
Computed By JH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cc/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I(3)c DP 8/17	RTI	—	7.90		70.8	28.7	40.6		
A-I(1)a DP 8/18	PEI	BJ936	18.96			36.1	77.5		
A-I(1)b DP 8/18	PEI	BJ937	21.49				87.9		
A-I(1)c DP 8/18	RTI	—	24.19				98.9		
A-I(2)a DP 8/18	PEI	BJ946	22.23				90.9		
A-I(2)b DP 8/18	PEI	BJ947	21.83				89.2		
A-I(2)c DP 8/18	PEI	BJ948	25.37				104		
A-I(3)a DP 8/18	PEI	BJ957	23.46				95.9		
A-I(3)b DP 8/18	PEI	BJ958	22.06				80.2		
A-I(3)c DP 8/18	TRW	1624	43.2			↓	177		
A-I(1)a DP 8/19	PEI	BJ938	10.58			24.4	64.0		
A-I(1)b DP 8/19	PEI	BJ939	11.19				67.7		
A-I(1)c DP 8/19	RTI	—	12.68				76.7		
A-I(2)a DP 8/19	PEI	BJ949	12.32				74.5		
A-I(2)b DP 8/19	PEI	BJ950	14.99				90.7		
A-I(2)c DP 8/19	TRW	1616	164				992		
A-I(3)a DF 8/19	PEI	BJ959	11.85		↓	↓	71.7		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 97
Checked By H.B.K. Date 11-25-80
Computed By JH Date 11/29/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, ℓ/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I(3)b DP 8/19	PEI	BJ960	13.03		70.8	24.4	78.8		
A-I(3)c DP 8/19	TRW	1604	21.6		|	↓	131		
A-I(1)a DP 8/20	PEI	BJ940	13.90		|	23.0	89.2		
A-I(1)b DP 8/20	PEI	BJ941	12.57		|	|	80.7		
A-I(1)c DP 8/20	TRW	1615	21.9		|	|	141		
A-I(2)a DP 8/20	PEI	BJ951	12.50		|	|	80.2		
A-I(2)b DP 8/20	PEI	BJ952	13.48		|	|	86.5		
A-I(2)c DP 8/20	RTI	-	16.54		|	|	106		
A-I(3)a DP 8/20	PEI	BJ961	15.06		|	|	86.6		
A-I(3)b DP 8/20	PEI	BJ962	15.78		|	|	101		
A-I(3)c DP 8/20					|	↓			no sample reported
A-I(1)a DP 8/21	TRW	1607	16.6		|	28.7	85.4		
A-I(1)b DP 8/21	TRW	1606	3.9		|	|	20.1		
A-I(1)c DP 8/21	TRW	1603	20.1		|	|	103		
A-I(2)a DP 8/21	TRW	1611	24.3		|	|	125		
A-I(2)b DP 8/21	TRW	1602	N.D.		|	|	N.D		
A-I(2)c DP 8/21	TRW	1608	12.9		↓	↓	66.3		

CLIENT EMSL /EPA

LOCATION

SUBJECT PERC field sample data

PN

Sheet No. 48

Checked By H.B.K. Date 11-25-80

Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
A-I(3)a DP 8/21	TRW	1601	15.0		70.8	28.7	77.1		
A-I(3)b DP 8/22	TRW	1613	5.4		↓	↓	27.8		
A-I(3)c DP 8/21	RTI TRW	RTI 1612	2435 23.2		↓	↓	128 119		VOID Two samples reported
A-I(1)a DP 8/22	TRW	1619	22.5		↓	29.0	115		
A-I(1)b DP 8/22	TRW	1620	31.2		↓	↓	159		
A-I(1)c DP 8/22	RTI	—	20.44		↓	↓	104		
A-I(2)a DP 8/22	TRW	1623	14.4		↓	↓	73.3		
A-I(2)b DP 8/22	TRW	1614	25.2		↓	↓	128		
A-I(2)c DP 8/22	TRW	1617	21.3		↓	↓	108		
A-I(3)a DP 8/22	TRW	1621	28.7		↓	↓	146		
A-I(3)b DP 8/22	TRW	1618	19.3		↓	↓	98		
A-I(3)c DP 8/22	TRW	1622	29.4		↓	↓	150		
E-I(1)a DP 8/30	PEI	BJ963	1043.9		↓	28.7	5368		
E-I(1)b DP 8/30	PEI	BJ964	1025.1		↓	↓	5271		
E-I(1)c DP 8/30	TRW	1663	1380.6		↓	↓	7100		
E-I(2)a DP 8/30	PEI	BJ976	1456.5		↓	↓	7100		
E-I(2)b DP 8/30	PEI	BJ977	848.4		↓	↓	4363		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
Sheet No. 4B
Checked By H.B.E. Date 11-25-80
Computed By AH Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total μg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, l/m	Sample volume, l	PPB	Corrected PPB	
E-I(2)c DP 8/30	TRW	1665	1253.0		70.8	28.7	6443		
E-I(3)a DP 8/30	PEI	BJ987	767.8				3948		
E-I(3)b DP 8/30	PEI	BJ988	1167.1				6002		
E-I(3)c DP 8/30	TRW	1652	1089.1			↓	5601		
E-I(1)a DP 8/31	PEI	BJ965	464.9			22.7	3023		
E-I(1)b DP 8/31	PEI	BJ966	490.9				3192		
E-I(1)c DP 8/31	RTI	-	721.21				4689		
E-I(2)a DP 8/31	PEI	BJ978	487.6				3170		
E-I(2)b DP 8/31	PEI	BJ979	626.5				4073		
E-I(2)c DP 8/31	TRW	1651	679.5				4418		
E-I(3)a DP 8/31	PEI	BJ959	329.2				2140		
E-I(3)b DP 8/31	PEI	BJ990	342.1				2224		
E-I(3)c DP 8/31	PEI	BJ991	346.7			↓	2254		
E-I(1)a DP 9/1	PEI	BJ967	765.2			27.9	4048		
E-I(1)b DP 9/1	PEI	BJ968	773.9				4094		
E-I(1)c DP 9/1	PEI	BJ969	851.1				4502		
E-I(2)a DP 9/1	PEI	BJ980	707.9		↓	↓	3745		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 52
Checked By H.B.K. Date 11-25-80
Computed By Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, ℓ/m	Sample volume, ℓ	PPB	Corrected PPB	
E-I(2)b DP 9/1	PEI	BJ981	1546.4		70.8	27.9	8180		
E-I(2)c DP 9/1	TRW	1655	1293.5		│	│	6842		
E-I(3)a DP 9/1	PEI	BJ992	593.1		│	│	3137		
E-I(3)b DP 9/1	PEI	BJ993	593.1		│	│	3137		
E-I(3)c DP 9/1	TRW	1667	874.7		│	↓	4627		
E-I(1)a DP 9/2	PEI	BJ970	1092.3		│	34.0	4741		
E-I(1)b DP 9/2	PEI	BJ971	1096.6		│	│	4760		
E-I(1)c DP 9/2	TRW	1660	1419.8		│	│	6163		
E-I(2)a DP 9/2	PEI	BJ982	1090.3		│	│	4733		
E-I(2)b DP 9/2	PEI	BJ983	2211.4		│	│	9599		
E-I(2)c DP 9/2	TRW	1659	1392.2		│	│	6043		
E-I(3)a DP 9/2	PEI	BJ994	912.4		│	│	3960		
E-I(3)b DP 9/2	PEI	BJ995	897.8		│	│	3897		
E-I(3)c DP 9/2	TRW	1666	1149.1		│	↓	4988		
E-I(1)a DP 9/3	PEI	BJ972	162.4		│	32.9	729		
E-I(1)b DP 9/3	PEI	BJ973	152.3		│	│	683		
E-I(1)c DP 9/3	TRW	1668	217.8		↓	↓	977		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
Sheet No. 57
Checked By H.B.K. Date 11-25-80
Computed By S H Date 11/24/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C^3/m	Sample volume, ℓ	PPB	Corrected PPB	
E-I-(2)a DP 9/2	PEI	BJ984	437.4		70.8	32.9	1971		
E-I(2)b DP 9/3	PEI	BJ985	276.4		↓	↓	1240		
E-I(2)c DP 9/3	RTI	—	364.53		↓	↓	1635		
E-I(3)a DP 9/3	PEI	BJ996	171.5		↓	↓	769		
E-I(3)b DP 9/3	PEI	BJ997	175.2		↓	↓	786		
E-I(3)c DP 9/3	TRW	1650	233.4		↓	↓	1047		
E-I-(1)a DP 9/4	TRW	1656	1464.6		↓	33.3	6491		
E-I(1)b DP 9/4	TRW	1657	1707.1		↓	↓	7566		
E-I(1)c DP 9/4	PEI	BJ974	1135.9		↓	↓	5096		
E-I(2)a DP 9/4	TRW	1658	2096.4		↓	↓	9291		
E-I(2)b DP 9/4	TRW	1648	1677.5		↓	↓	7435		
E-I(2)c DP 9/4	TRW	1662	1492.9		↓	↓	6617		
E-I(3)a DP 9/4	TRW	1661	1074.3		↓	↓	4761		
E-I(3)b DP 9/4	TRW	1653	1350.8		↓	↓	5987		
E-I(3)c DP 9/4	TRW	1646	1245.2		↓	↓	5519		
E-I(1)a DP 9/5	TRW	1670	2101.9		↓	31.5	9848		
E-I(1)b DP 9/5	TRW	1649	2051.2		↓	↓	9611		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field sample data

PN
Sheet No. 52
Checked By H.B.K Date 11-25-80
Computed By AH Date 11/25/80

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, c^3/m	Sample volume, ℓ	PPB	Corrected PPB	
E-I(1)c DP 9/5	PEI	BJ975	1423.3		70.8	31.5	6662		
E-I(2)a DP 9/5	TRW	1669	1159.2		↓	↓	5431		
E-I(2)b DP 9/5	TRW	1664	1207.5		↓	↓	5658		
E-I(2)c DP 9/5	PEI	BJ986	902.4		↓	↓	4224		
E-I(3)a DP 9/5	TRW	1654	944.8		↓	↓	4427		
E-I(3)b DP 9/5	TRW	1647	1003.1		↓	↓	4700		
E-I(3)c DP 9/5	PEI	BJ998	851.3				3985		

CLIENT EMSL /EPA
LOCATION
SUBJECT PERC field Sample data

PN
Sheet No. 57
Checked By H.B.K. Date 11-25-80
Computed By JH Date 11/25

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total μg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, cm^3/m	Sample volume, ℓ	ppb	Corrected ppb	
G-I(1) 10/3	PEI	BL183	0.325		233	338.5	0.142	0.168	
G-I(2) 10/3	PEI	BL187	0.491		233	338.5	0.214	0.253	
G-I(3) 10/3	RTI	-	N/D		238	345.8	N/D	—	heavily contaminated with other species
G-I(1) 10/4	PEI	BL 194	0.334		230	332.4	0.148	0.175	
G-I(2) 10/4					230	332.4			
G-I(3) 10/4	RTI	-	N/D		233	336.7	N/D	—	heavily contaminated with other species
G-I(1) 10/5	PEI	BL185	224.9		233	333.7	99.4	117.5	
G-I(2) 10/5	PEI	BL188	157.9		228	326.5	71.3	84.3	
G-I(3) 10/5	RTI	—	136.07		226	323.6	62.0	103.2	
G-I(1) 10/6	PEI	BL186	33.76		230	330.5	15.1	17.8	
G-I(2) 10/6	RTI	—	32.72		228	327.6	14.7	24.5	
G-I(3) 10/6					209	300.3			
G-I(1) 10/7	PEI	BL 300	37.40		228	327.6	16.8	19.9	
G-I(2) 10/7	RTI	—	29.05		223	320.5	13.4	22.3	
G-I(3) 10/7	PEI	BL301	16.15		217	311.8	7.64	9.03	
G-I(1) 10/8	PEI	BL367	42.65		230	331.0	19.0	22.46	
G-I(2) 10/8					226	325.2			

CLIENT EMSL /EPA

LOCATION

SUBJECT PERC Field Sample data

PN

Sheet No. 59

Checked By H.B.K. Date 11-25-80

Computed By Date 11/25

Sample field identification No.	Laboratory performing analysis	Laboratory identification No.	Total µg found	~~Desorption efficiency (D.E.)~~	Mean sample flow rate, C³/m	Sample volume, ℓ	PPB	Corrected PPB	
G-I(3) 10/8	RTI	—	27.93		168	242	17.0	28.3	
G-I(1) 10/9	PEI	BL 368	52.43		230	331.	23.4	27.7	
G-I(2) 10/9	PEI	BL370	16.11		223	321.	7.40	8.75	
G-I(3) 10/9	PEI	BL 369	20.99		230	331	9.35	11.05	
G-I(1) 10/10	PEI	BL535	21.12		239	337	9.24	10.92	
G-I(2) 10/10					243	350			
G-I(3) 10/11	RTI		22.21		234	337	9.72	16.17	
G-I(1) 10/11	PEI	BL536	19.43		243	351	8.16	9.64	
G-I(2) 10/11	PEI	BL 537	9.91		247	357	4.09	4.83	
G-I(3) 10/11	PEI	BL 538	8.29		238	344	3.55	4.20	

APPENDIX C

PREPARATION OF QUALITY ASSURANCE TEST SAMPLES

43U-1847-27

PREPARATION OF QUALITY ASSURANCE TEST SAMPLES: CHARCOAL-TYPE, AIR-SAMPLING TUBES AND PERSONAL MONITORING BADGES LOADED WITH PERCHLOROETHYLENE

by

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U. S. Environmental Protection Agency
Environmental Monitoring Systems Laboratory
Quality Assurance Division
Research Triangle Park, North Carolina 27709

December 1980

1.0 DESCRIPTION OF TASK

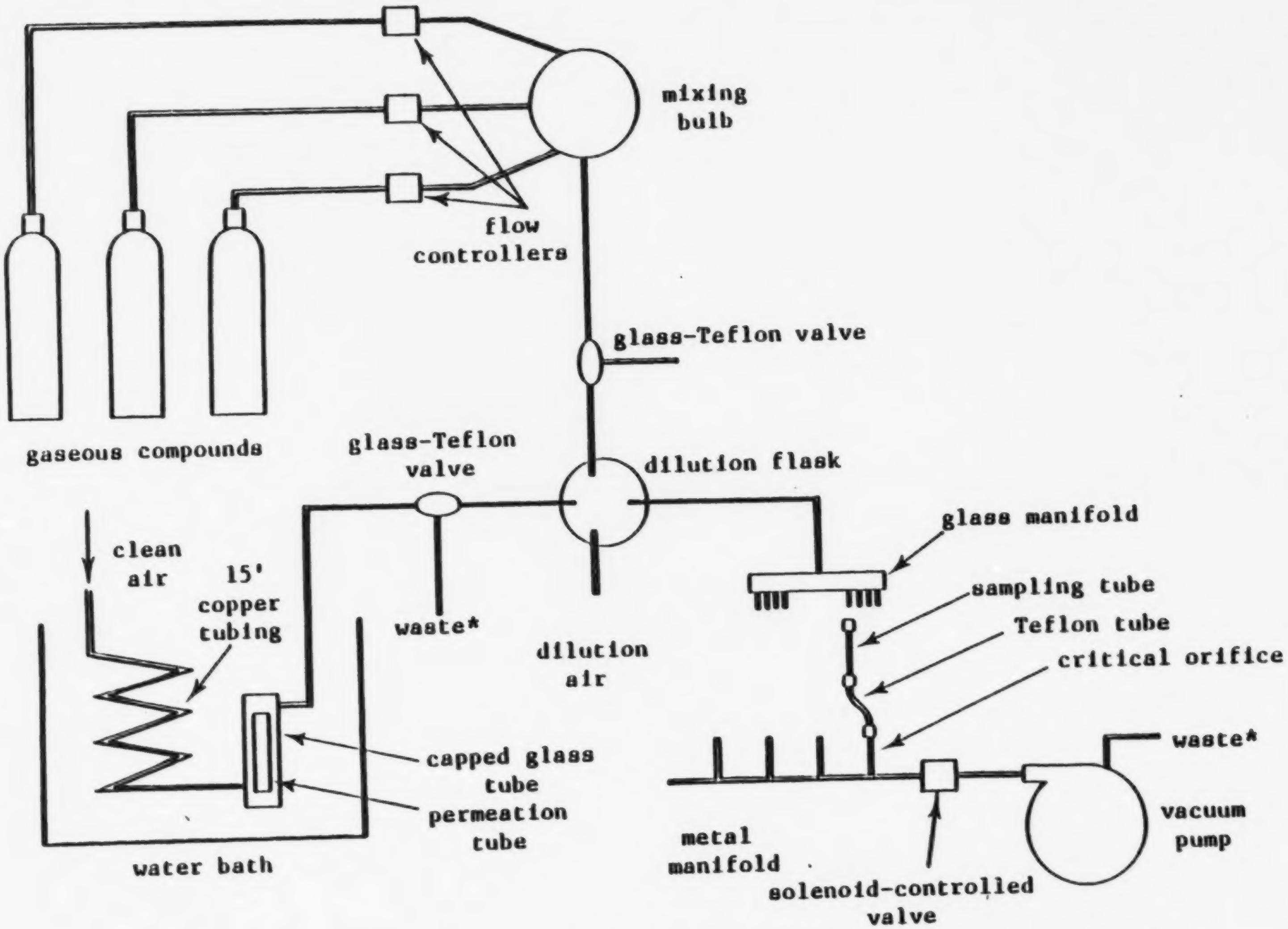
The objectives of this task were: (1) to load charcoal-type, air sampling tubes with perchloroethylene in two different mass ranges, 1-10 μg and 1000-20000 μg, which represent outside and inside sampling levels, respectively; (2) to load personal monitoring badges with perchloroethylene in the range of 500-2000μg; (3) to perform analyses to verify these amounts; and (4) to provide PEDCo, TRW, and RTI with loaded badges and tubes to be analyzed as quality assurance samples. Accordingly, RTI loaded the tubes and badges, verified the amounts loaded and delivered 40 tubes and 16 badges to PEDCo, 30 tubes and 12 badges to TRW and 12 tubes and 10 badges to RTI.

This report describes the various activities performed during the course of this task. Section 2 of the report describes the experimental procedures used during sample loading. Section 3 presents a description of the verification procedures and results.

2.0 LOADING AIR-SAMPLING TUBES

2.1 Sample Generation Systems

The system used to load the charcoal-type, air-sampling tubes with lower levels of perchloroethylene is shown in Figure 1. A cylinder containing 9.09 ppm perchloroethylene was used as the source for loading the tubes. The concentration in this cylinder had been verified previously. The cylinder and five sampling tubes were connected into the system at one time. SKC air-sampling tubes containing 100 mg front/50 mg back of charcoal (lot no. 107) were used in this study. The rates of flow through the air-sampling tubes were determined by critical orifices between the tubes and a vacuum pump. The flow rates through these orifices, which were prepared from 1/16" O.D. stainless steel, capillary tubing, had average flow rates shown in Table 1. The flows through the orifices were determined using a bubble flow meter with an "opened" charcoal tube in line, as the flow resistance of a tube has a slight effect upon the actual flow rate. Flows through the air-sampling tubes were controlled by a valve (either totally open or


gaseous compounds
flow controllers
mixing bulb
glass-Teflon valve
glass-Teflon valve
dilution flask
clean air
15' copper tubing
waste*
dilution air
capped glass tube
permeation tube
water bath
glass manifold
sampling tube
Teflon tube
critical orifice
waste*
metal manifold
solenoid-controlled valve
vacuum pump

Permeation/dilution system (total system to be placed in hood, excluding cylinders)

*Waste to be collected in impinger solution or directed into maximum flow region of hood exhaust stream.

Figure 1. Permeation/dilution system.

TABLE 1
CRITICAL ORIFICE FLOW RATES

Orifice	Average Flow Rate*
1	76.6 ± 0.24 (0.3%)
2	89.5 ± 1.51 (1.7%)
3	93.4 ± 0.34 (0.4%)
4	79.4 ± 0.19 (0.3%)
5	77.8 ± 0.27 (0.4%)

* Average is for period 9/4/80 - 9/5/80

totally closed) between the critical orifices and the vacuum pump. Initiation (and stabilization) or cessation of the flow with opening or closing the valve, respectively, was very rapid, i.e., it occured in less than one second. It was assumed that loading onto the air-sampling tubes did not begin until the compound was actually drawn into the charcoal bed, and thus the amount loaded onto a tube is determined by the relationship,

$$\left(\begin{array}{c}\text{source concentration}\\ \mu\text{g/mL}\end{array}\right) \times \left(\begin{array}{c}\text{critical orifice}\\ \text{flow, mL/min}\end{array}\right) \times \left(\begin{array}{c}\text{loading time,}\\ \text{min}\end{array}\right)$$

The apparatus used to load the tubes at higher levels is shown in Figure 2. In this system, neat perchloroethylene is injected into and vaporized in a heated(temperature known), stainless steel tube. An air-sampling tube is attached to the stainless steel tube. The vapor is drawn out of the stainless steel tube and into the air-sampling tube by means of a vacuum pump/critical orifice combination. Air flow was continued about five minutes after injection to assure complete transfer of the vapor into the air-sampling tube. It was necessary to load these tubes with neat liquid in that using permeation tubes or available cylinders as sources would require an unreasonable amount of time to load the tubes at these high levels (~10000 μg). The density of perchloroethylene is 1623 μg/μL and thus 6 μL delivers about 10000 μg. The apparatus used to load the personal monitoring badges is shown in

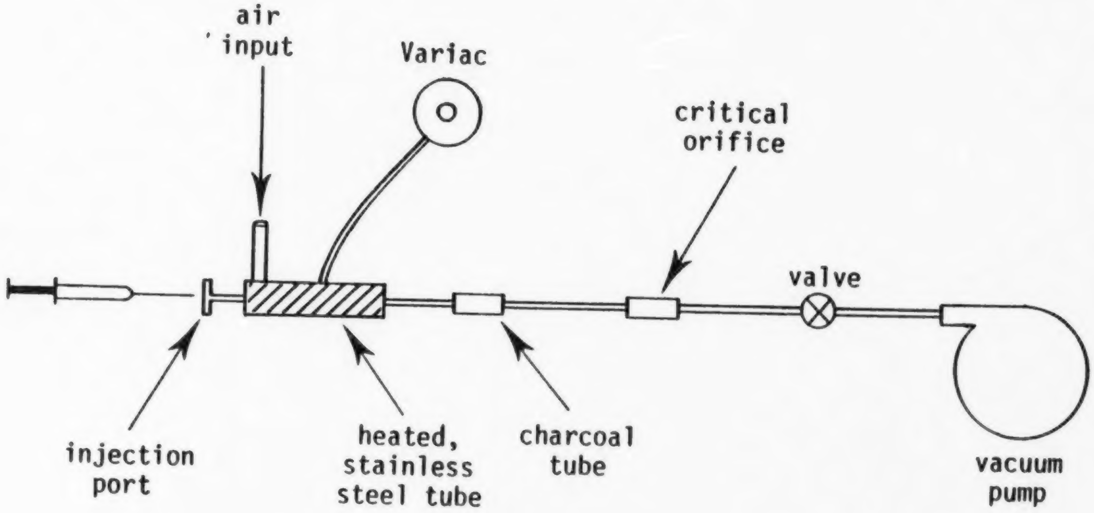

air
input
Variac
critical
orifice
valve
injection
port
heated,
stainless
steel tube
charcoal
tube
vacuum
pump

Figure 2. Charcoal tube spiking system.

Figure 3. A high concentration cylinder (440 ppm) was used as the perchloroethylene source for loading the badges. After perchloroethylene flow was established, four to six 3M and/or DuPont badges were hung in the chamber and exposed for a preset amount of time. The amount of perchloroethylene loaded was determined by the concentration of perchloroethylene in the chamber and the effective "flow rate" of the badges, as described below; that is

$$\mu\text{g loaded} = \begin{pmatrix}\text{source} \\ \text{concentration} \\ \mu\text{g/mL}\end{pmatrix} \text{X} \begin{pmatrix}\text{effective badge} \\ \text{"flow rate",} \\ \text{mL/min}\end{pmatrix} \text{X} \begin{pmatrix}\text{loading} \\ \text{time,} \\ \text{min}\end{pmatrix}$$

2.2 Sample Loading

Perchloroethylene in two different ranges was to be loaded on the air-sampling tubes, 1-10 μg representing outside sampling levels, and 1000-20000 μg representing inside sampling levels. It was decided that three and four different levels in the lower and higher ranges, respectively, would be loaded in order to provide more meaningful quality assurance testing.

The lower levels were loaded using a source concentration of 9.09 ppm and variable loading times. The actual source concentration in μg/mL is, of course, the concentration of the compound of interest as it enters the air-sampling tubes. This is calculated using the ideal gas law, PV = nRT, with knowledge of (1) the concentration of the compound of interest in the cylinder in terms of volume-to-volume ratio; (2) the temperature of the loading apparatus; and (3) the pressure of the sample in the loading manifold. The average orifice flows are presented above; the flows used in the calculations were those measured at the time of loading an actual batch of tubes. The lower-range amounts of perchloroethylene loaded on the air-sampling tubes have been calculated and are listed in Table 2. The higher-range amounts loaded were 2, 5, 7, or 9 μL of neat perchloroethylene, which correspond to 3246, 8115, 11361, and 14607 μg, respectively. The higher-range amounts loaded on the tubes are listed in Table 3.

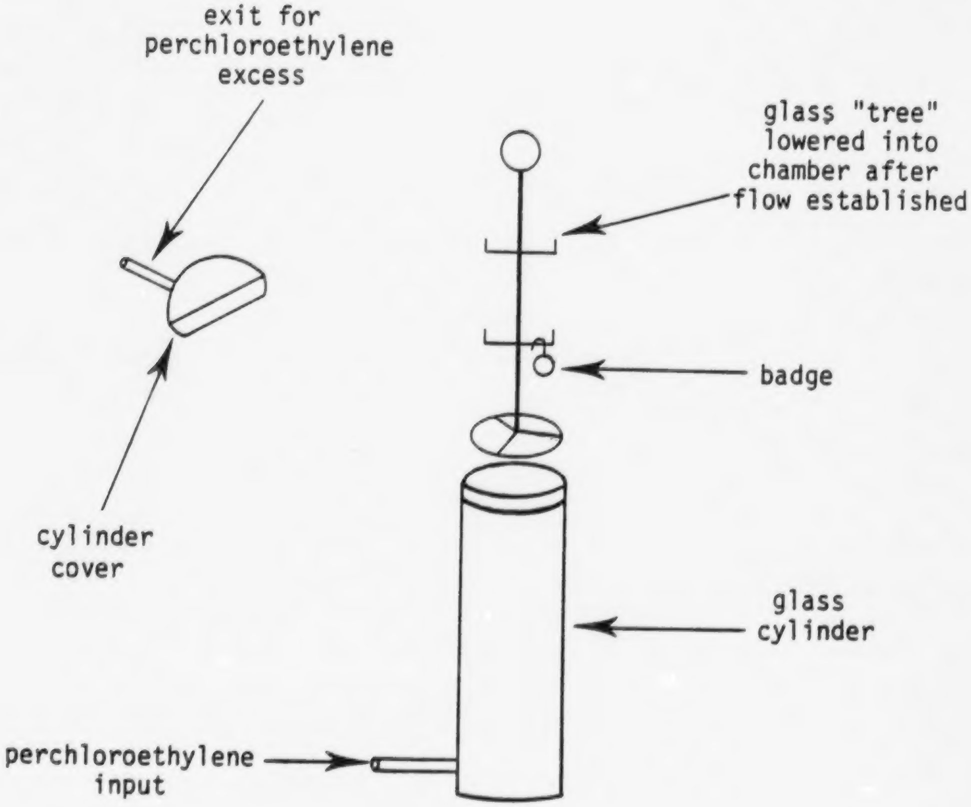

exit for perchloroethylene excess
glass "tree" lowered into chamber after flow established
badge
cylinder cover
glass cylinder
perchloroethylene input

Figure 3. Badge loading system.

TABLE 2
Amounts of Perchloroethylene Loaded on Charcoal-Type, Air-Sampling Tubes Representing Outside Levels

RTI Tube No.	Perchloroethylene Loaded, μg
P-OT1	1.83
P-OT2	6.40
P-OT3	4.57
P-OT4	5.35
P-OT5	7.48
P-OT6	2.14
P-OT7	7.81
P-OT8	5.58
P-OT9	6.64
P-OT10	2.20
P-OT11	1.90
P-OT12	4.74
P-OT13	6.50
P-OT14	1.86
P-OT15	4.64
P-OT16	6.40
P-OT17	1.83
P-OT18	7.48
P-OT19	4.57
P-OT20	5.35
P-OT21	2.14
P-OT22	5.58
P-OT23	2.23
P-OT24	7.81
P-OT25	4.74
P-OT26	6.64
P-OT27	1.90
P-OT28	6.50

TABLE 2 (Continued)
Amounts of Perchloroethylene Loaded on Charcoal-Type, Air-Sampling Tubes Representing Outside Levels

RTI Tube No.	Perchloroethylene Loaded, μg
P-OT29	4.64
P-OT30	1.86
P-OT31	1.83
P-OT32	4.57
P-OT33	6.40
P-OT34	2.14
P-OT35	5.35
P-OT36	2.23
P-OT37	5.58
P-OT38	4.74
P-OT39	7.48
P-OT40	1.90
P-OT41	7.81
P-OT42	4.64
P-OT43	1.86
P-OT44	6.64
P-OT45	6.50
P-OT46	4.57
P-OT47	5.35
P-OT48	5.58
P-OT49	4.74
P-OT50	4.64

TABLE 3
Amounts of Perchloroethylene Loaded on Charcoal-Type, Air-Sampling Tubes Representing Inside Levels

RTI Tube No.	Perchloroethylene Loaded, µg
P-IT1	3246
P-IT2	8115
P-IT3	11361
P-IT4	14607
P-IT5	8115
P-IT6	11361
P-IT7	14607
P-IT8	3246
P-IT9	11361
P-IT10	14607
P-IT11	3246
P-IT12	8115
P-II13	14607
P-IT14	3246
P-IT15	8115
P-II16	11361
P-IT17	3246
P-IT18	8115
P-IT19	11361
P-IT20	14607
P-IT21	8115
P-IT22	11361
P-IT23	14607
P-IT24	3246
P-IT25	11361
P-IT26	14607
P-IT27	8115
P-IT28	3246

TABLE 3 (Continued)
Amounts of Perchloroethylene Loaded on Charcoal-Type, Air-Sampling Tubes Representing Inside Levels

RTI Tube No.	Perchloroethylene Loaded, μg
P-IT29	14607
P-IT30	3246
P-IT31	8115
P-IT32	11361
P-IT33	3246
P-IT34	8115
P-IT35	11361
P-IT36	14607
P-IT37	8115
P-IT38	11361
P-IT39	14607
P-IT40	3246
P-II41	11361
P-IT42	14607
P-IT43	8115
P-II44	3246
P-IT45	14607
P-IT46	3246
P-IT47	8115
P-IT48	11361
P-IT49	14607
P-IT50	14607

The personal monitoring badges were loaded at two levels using a source concentration of 440 ppm and variable exposure time. The perchloroethylene sample flow through the loading chamber was approximately 300 mL/min. The effective badge flow rates for percloroethylene were 28.2 mL/min for 3M badges and 35.4 mL/min for DuPont badges; these values were found in literature supplied by the manufacturers. The amounts of perchloroethylene loaded on badges have been calculated and are shown in Table 4.

3.0 SAMPLE VERIFICATION

Analysis of tubes and badges for purposes of verification were performed using gas chromatography (GC) with flame ionization detection (FID) and electron capture (EC) detection. Actual field samples collected indoors ("inside" tubes and badges) and associated quality assurance samples were to be analyzed using GC with FID detection. Field samples collected outdoors ("outside" tubes) and associated quality assurance samples were to be analyzed using GC with electron capture (EC) detection.

The verification analyses of "inside" tubes and badges were performed on a Hewlett-Packard Model 5880 gas chromatograph equipped with a flame ionization detector. The column utilized was a 20' x 1/8" O.D. stainless steel column packed with 10% SP-1000 on 80/100 Supelcoport supplied by Supelco, Incorporated. Helium was used as the carrier gas at a flow rate of 30 cc/min. The column was held at 125°C. Injection and detector port temperatures were maintained at 200°C. All peaks were integrated with a Hewlett-Packard Model 5880A data processor. A Perkin-Elmer Model 3920B GC with EC detection was used for analyses of "outside" tubes. The column was 6' X¼" glass packed with 0.1% SP—1000 on 80/100 Supelcoport. The carrier gas was 5% methane/95% argon flowing at 27 cc/min; the oven temperature was set at 150°C. Peaks were integrated with a Spectra Physics "Minigrator".

As stated, the quantity of perchloroethylene loaded onto the charcoal tubes was determined using GC and a series of known standards.

TABLE 4
Amounts of Perchloroethylene Loaded on Personal Monitoring Air-Sampling Badges

RTI Badge No.	Badge Type	Perchloroethylene Loaded, μg
P-B1	3M	1244
P-B2	3M	1244
P-B3	3M	1824
P-B4	3M	1244
P-B5	3M	1824
P-B6	3M	0 (blank)
P-B7	3M	1244
P-B8	3M	1244
P-B9	3M	1824
P-B10	3M	0 (blank)
P-B11	DuPont	1561
P-B12	DuPont	1561
P-B13	DuPont	1561
P-B14	DuPont	2290
P-B15	DuPont	2290
P-B16	DuPont	1561
P-B17	DuPont	1561
P-B18	DuPont	1561
P-B19	DuPont	2290
P-B20	DuPont	2290
P-B21	3M	1244
P-B22	3M	1244
P-B23	3M	1824
P-B24	3M	1244
P-B25	3M	1244
P-B26	3M	1824
P-B27	3M	1244

TABLE 4 (Continued)
Amounts of Perchloroethylene Loaded on Personal Monitoring Air-Sampling Badges

RTI Badge No.	Badge Type	Perchloroethylene Loaded, μg
P-B28	3M	1824
P-B29	3M	1244
P-B30	3M	1824
P-B31	DuPont	2290
P-B32	DuPont	2290
P-B33	DuPont	1561
P-B34	DuPont	2290
P-B35	DuPont	1561
P-B36	DuPont	2290
P-B37	DuPont	1561
P-B38	DuPont	1561
P-B39	DuPont	1561
P-B40	DuPont	2290
P-B41	DuPont	2290
P-B42	DuPont	2290
P-B43	DuPont	2290
P-B44	DuPont	1561
P-B45	DuPont	2290
P-B46	DuPont	1561
P-B47	DuPont	2290
P-B48	DuPont	1561
P-B49	DuPont	1561
B-B50	DuPont	1561
B-B51	DuPont	0 (blank)
B-B52	DuPont	0 (blank)

The standards for "inside" tubes, varying in concentration over the range of interest, 16130-6.2 μg/mL, were prepared in Baker "analyzed" grade carbon disulfide (CS_2). Regression analysis for these standards was performed and the correlation coefficient obtained was 0.99999. The standards for "outside" tubes varied from 161 μg/mL to 0.645 μg/mL and were prepared in 25% CS_2/75% CH_3OH. After loading the tubes and badges with known amounts of perchloroethylene, the tubes were stored at 0°C. Prior to analysis, each 150 mg charcoal tube was scored with a triangular file and broken above the glass wool and retainer. The glass wool and retainer were discarded and the front and back sections of the charcoal were transferred into a glass vial containing solvent. In the case of DuPont badges, the sorbent strip was removed from the holder, cut into small pieces, placed in a desorption vial with 1 mL of CS_2 and agitated for at least one hour. With 3M badges, 1 mL of CS_2 was pipetted directly into the badge and was allowed to stand for at least one hour with occasional agitation. The amount of solvent used for desorption was 1 mL for "inside" tubes and 2 ml for "outside" tubes. The glass vials containing the charcoal and solvent were crimp-sealed with a Teflon-lined cap. The vials were allowed to stand for one hour. Five μL of a sample were injected into the GC. All injections of solution were made using the solvent flush technique. Also, at least three replicate measurements were made for each standard and test solution. Reagent blanks were analyzed and did not show the presence of measurable perchloroethylene. The results of the analyses of selected quality assurance samples are shown in Table 5.

TABLE 5
VERIFICATION RESULTS

RTI No.	Perchloroethylene Loaded, μg	Perchloroethylene Found, μg	Percent Bias, %	Percent Recovery,%
P-OT50	4.64	2.86	-38.4	61.6
P-IT4	14607	14238	-2.5	97.5
P-IT8	3246	3106	-4.3	95.7
P-B21(3M)	1244	567	-54.4	45.6
P-B33(DuPont)	1561	719	-53.9	46.1

As noted, the tubes showed good recovery using CS_2 as an extraction media in the high ranges. The CS_2/CH_3OH solvent showed fair recovery. Another tube, P-OT14, which was loaded with 1.86 μg, showed 98.9% recovery when extracted with pure CS_2. The badges however, showed poor recovery. A study of loading and recovery from badges using radio-labeled compounds will be necessary to explain the low recovery.

4.0 SUMMARY OF RESULTS

Fifty charcoal-type, air-sampling tubes were loaded with three levels of perchloroethylene in the range of 1-8 μg; fifty charcoal-type air-sampling tubes were loaded with four levels of perchloroethylene in the range of 3000-15000 μg; finally fifty personal, air-sampling badges (3M and DuPont) were loaded with two levels of perchloroethylene in the range of 1000-2500 μg. Good recovery (96-99%) was obtained with the tubes whereas poor recovery was obtained with badges (~45%). Quality control procedures used during the course of this task included: (1) using verified sources of perchloroethylene for loading; (2) making replicate measurements; and (3) analyzing blank samples.

APPENDIX D

QUALITY ASSURANCE PRECISION DATA

TABLE D-1. REPLICATE LABORATORY ANALYSIS OF OUTDOOR CHARCOAL TUBE SAMPLES BY PEDCo

A, µg	B, µg	$\overline{X}$	SD
2.56	2.40	2.48	0.11
1.42	1.36	1.39	0.04
3.50	3.86	3.68	0.25
5.39	5.44	5.42	0.04
3.65	3.71	3.68	0.04
31.5	31.6	31.55	0.07
3.95	4.12	4.04	0.12
4.25	5.48	4.87	0.87
1.87	1.94	1.91	0.05
24.43	23.22	23.88	0.86
0.71	0.88	0.80	0.12
29.14	29.85	29.50	0.50
9.26	9.47	9.37	0.15

C.V. = 2.6%

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-2. REPLICATE LABORATORY ANALYSIS OF INDOOR CHARCOAL TUBE SAMPLES BY PEDCo

A, µg	B, µg	$\overline{X}$	SD
36.54	36.41	36.5	0.1
16.12	17.70	16.9	1.1
207.5	212.1	209.8	3.3
433.2	428.6	430.9	3.3
80.40	79.59	80.0	0.6
124.2	124.8	124.5	0.4
160.0	163.3	161.6	2.3
629.6	622.1	625.9	5.3
1257.2	1278.7	1268.0	15.2
606.8	590.9	598.9	11.2
18.37	17.24	17.8	0.8
581.3	581.3	581.3	0.0
20.54	25.73	23.1	3.7
68.48	64.24	66.4	3.0
76.94	66.46	71.7	7.4
78.93	71.81	75.4	5.0
56.0	60.70	58.4	3.3
19.58	20.69	20.1	0.8
356.77	350.62	353.7	4.3
10.5	10.9	10.7	0.3
70.3	73.4	71.9	2.2
325.4	322.1	323.8	2.3
252.0	252.8	252.4	0.6
347.9	352.3	350.1	3.1
34.84	35.39	35.1	0.4
756.9	751.5	754.2	3.8

C.V. = 1.3%.

SD = Standard Deviation.
C.V. Coefficient of Variation.

TABLE D-3. REPLICATE LABORATORY ANALYSIS OF OUTDOOR CHARCOAL TUBE SAMPLES BY RTI

A, μg	B, μg	C, μg	$\overline{X}$	SD
9.135	9.568	9.196	9.30	0.23
3.340	2.986	3.449	3.26	0.24
0.850	0.957	1.013	0.94	0.08
0.405	0.519	0.576	0.50	0.09
1.709	1.684	1.707	1.70	0.01
2.854	2.824	2.722	2.80	0.07

C.V. = 3.9%.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-4. REPLICATE LABORATORY ANALYSIS OF INDOOR CHARCOAL TUBE SAMPLES BY RTI

A, μg	B, μg	$\overline{X}$	SD
15.72	14.8	15.3	0.64
33.97	29.08	31.5	3.46
17.13	18.22	17.7	0.77
11.40	12.34	11.9	0.66
53.56	58.39	56.0	3.42
21.91	22.69	22.3	0.55
184.49	186.29	185.4	1.27
532.94	539.56	536.2	4.54
111.91	111.88	111.9	0.05
1696.32	1752.97	1724.8	40.3

C.V. = 2.1%.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-5. REPLICATE ANALYSIS OF OUTDOOR CHARCOAL TUBE STANDARDS BY TRW[a]

μg conc.	A[b]	B[b]	C[b]	$\overline{X}$	SD
Blank	0.785	0.795	0.803	0.794	0.099
0.244	1.746	1.738	1.780	1.754	0.022
2.44	10.79	10.66	10.75	10.73	0.07
4.89	19.60	19.89	19.39	19.63	0.25

C.V. = 1.3%.

[a] Performed with automatic sampler, no field sample replicate analysis data available.

[b] Expressed in terms of area counts x 10^6.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-6. REPLICATE ANALYSIS OF INDOOR CHARCOAL TUBE SAMPLES BY TRW

A, μg	B, μg	$\overline{X}$	SD
25.2	14.2	19.7	7.8
21.3	22.6	22.0	0.92
1089	1127	1108	26.9
1465	1463	1464	1.4
1381	1309	1345	50.9

C.V. = 2.2%.

[a] Discard from calculation.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-7. ANALYSIS OF COLLOCATED OUTDOOR CHARCOAL TUBE SAMPLES BY PEDCo

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
0.097	0.139		0.188	0.03
(0.171)[a]	5.44	5.19	5.32	0.18
	0.096	0.138	0.117	0.03
2.10	1.84	1.86	1.93	0.14
0.56	0.38		0.47	0.13
1.77	2.19	1.14	1.70	0.53
1.67	2.35	0.82	1.61	0.77
1.34	1.29		1.32	0.04
34.0	28.6	6.09	22.9[a]	14.8[a]
0.90	1.18	1.39	1.16	0.25
20.9	11.1		16.0	6.93
0.53	0.32		0.43	0.15
0.84	1.02		0.93	0.13
5.28	6.30	5.50	5.69	0.54
5.50	2.92	4.37	4.26	1.29
1.36	1.39		1.38	0.02
0.28	0.57		0.43	0.21
9.67	8.04		8.86	1.15
5.04	4.55		4.80	0.35
0.51	0.47	0.74	0.57	0.15
0.07	0.17		0.12	0.07
1.76	0.93		1.35	0.59
1.84	1.93		1.89	0.06
0.35	0.43		0.39	0.06
1.18	1.17		1.18	0.01
0.38	0.74		0.56	0.25
0.64	0.40	0.45	0.50	0.13
0.047	0.053	(0.47)[a]	0.05	0.004
0.32	(0.11)[a]	0.33	0.33	0.007
0.17	0.18		0.18	0.007

(continued)

TABLE D-7 (continued)

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
	10.4	9.91	10.2	0.35
3.22	3.40	3.40	3.34	0.10
0.85	1.16		1.01	0.22
	1.30	1.31	1.31	0.01
1.48	1.50	1.47	1.48	0.02
1.23	0.96		1.10	0.19
0.84	0.91	0.91	0.89	0.04
0.27	0.21		0.24	0.04
1.11	1.30		1.21	0.13

C.V. = 18.1%.

[a] Excluded from calculation.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-8. ANALYSIS OF CO-LOCATED INDOOR CHARCOAL TUBE SAMPLES BY PEDCo

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
87.0	97.5	82.9	89.1	7.5
93.5	107.6	92.7	97.9	8.4
40.6	39.0	41.1	40.2	1.1
133.1	142.4	131.9	135.8	5.1
152.8	136.6	169.0	152.8	16.2
118.1		102.8	110.5	10.8
129.6	140.0	126.2	131.9	7.2
	115.7	106.6	111.2	6.4
165.5	166.7	187.5	173.2	12.4
	891	774	833.0	82.7
176	176	156	169.3	11.5
242	284	258	261.3	21.2
442	470	512	474.7	35.2
330	318		324.0	8.5
950	790		870	113.1
12,322	15,514	14,899	14,295	1694
19,605	14,066	7,941	13,871	5835
6,424	5,341	9,241	7,002	2013
3,948	7,095	4,254	5,099	1735
8,978	9,162	(13,316)[a]	9,070	130.1
5,748	(9,279)[a]	5,896	5,822	104.7
8,994	10,355	13,082	10,810	2082
9,014	11,773	7,030	9,272	2382
	1,468	1,791	1,630	228
1,445	990	1,490	1,308	277
9,640	9,992	7,734	9,122	1215
7,951	5,389	8,277	7,206	1582
8,397	9,275	11,151	9,607	1408
7,588		5,665	6,627	1360

(continued)

TABLE D-8 (continued)

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
937	998		968	43.1
796	741		769	38.9
2,187	2,205		2,196	12.7

C.V. = 19.0%

[a] Excluded from calculation.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-9. ANALYSIS OF COLLOCATED OUTDOOR CHARCOAL TUBE SAMPLES BY TRW

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
0.74	1.03	1.58	1.12	0.43
0.53	0.49	0.41	0.48	0.06
0.62[a]	6.05[a]		3.33[a]	3.84[a]
3.04	2.68		2.86	0.25
	1.30	1.30	1.30	0
1.80	0.43		1.12	0.97

C.V. = 24.9%.

[a] Excluded from calculation.

SD = Standard Deviation.
C.V. = Coefficient of Variation

TABLE D-10. ANALYSIS OF COLLOCATED INDOOR CHARCOAL TUBE SAMPLES BY TRW

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
109	110	126	115	9.5
134	122	87.8	115	24.0
187	306	200	231	65.3
249	139		194	77.8
196	194	192	194	2.0
282	419	477	392	100.0
958	994		975	24.0

C.V. = 13.7%.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-11. ANALYSIS OF FRONT AND BACK SECTIONS OF INDOOR CHARCOAL TUBE SAMPLES BY PEDCo

Sample No.	Front, μg	Back, μg	Total, F+B	% total, back
D-I(1) a CT 9/3	178.8	0.12	178.9	0.07
D-I(1) a CT 9/2	598.9	0.41	599.3	0.07
D-I(1) a CT 9/4	364.0	0.43	364.4	0.12
C-I(1) a CT 8/18	18.37	0.42	18.79	2.23
C-I(3) a CT 8/18	581.3	0.45	581.8	0.08
C-I(2) a CT 8/21	58.8	0.18	59.0	0.31
C-I(1) a CT 8/17	260.8	0.35	261.2	0.13
C-I(1) a CT 8/21	73.25	0.18	73.4	0.25
C-I(1) a CT 8/16	31.35	0.13	31.5	0.41
B-I(2) a CT 8/17	23.1	0.06	23.2	0.26
B-I(1) a CT 8/19	42.91	0.11	43.0	0.26
B-I(1) a CT 8/20	68.48	0.06	68.5	0.09
B-I(2) a CT 8/16	57.02	0.14	57.1	0.24
F-I(2) a CT 9/4	174.5	0	174.5	0.00
D-I(3) a CT 9/2	36.54	0.723	37.3	1.94
E-I(3) a CT 8/30	1257.2	0	1257.2	0.00
D-II(3) a CT 8/31	134.3	0.17	134.5	0.13
Average % PERC, back section				0.39
Standard deviation				0.65

TABLE D-12. ANALYSIS OF FRONT AND BACK SECTIONS OF OUTDOOR CHARCOAL TUBE SAMPLES BY PEDCo

Sample No.	Front, μg	Back, μg	Total, F+B	% total, back
D-III a CT 8/31	1.08	0.12	1.10	10.00
D-III a CT 9/2	5.39	0.04	5.43	0.74
D-IV a CT 9/2	13.92	0.05	13.97	0.36
C-II a CT 8/17	13.59	0.18	13.77	1.31
C-V a CT 8/21	2.86	0.99	3.85	25.71
C-V b CT 8/19	1.28	0.08	1.36	5.88
B-V b CT 8/18	2.05	0.08	2.13	3.76
B-V a CT 8/19	2.40	<0.03	<2.43	<1.23
B-IV a CT 8/20	2.00	0.17	2.17	7.83
A-V b CT 8/18	6.13	0.06	6.19	0.97
A-V a CT 8/22	1.08	0.13	1.21	10.74
A-III a CT 8/19	8.43	<0.03	<8.43	<0.35
			Average % PERC, back section	5.74
			Standard deviation	7.36

TABLE D-13. ANALYSIS OF FRONT AND BACK SECTIONS OF INDOOR CHARCOAL TUBE SAMPLES BY TRW

Sample No.	Front, μg	Back, μg	Total, F+B	% total, back
A-I(3) a CT 8/21	21.5	N.D.[a]	21.5	0.0
A-I(3) b CT 8/21	20.8	N.D.[a]	20.8	0.0
A-I(1) a CT 8/22	29.7	1.6	31.3	5.1
A-I(2) a CT 8/22	48.3	0.9	49.2	1.8
B-I(2) a CT 8/21	48.9	0.7	49.6	1.4
C-I(1) b CT 8/19	364.6	2.2	366.8	0.6
			Average % PERC, back section	1.5
			Standard deviation	1.9

[a] N.D. = None detected.

TABLE D-14. ANALYSIS OF FRONT AND BACK SECTIONS OF OUTDOOR CHARCOAL TUBE SAMPLES BY TRW

Sample No.	Front, μg	Back, μg	Total, F+B	% total, back
A-II b CT 8/17	0.3192	0.3481	0.6673	>50 VOID[a]
A-II b CT 8/20	0.7334	0.1997	0.9331	21.4
			Average % PERC, back section	21.4
			Standard deviation	N.A.

[a] Sample waterlogged in field.

TABLE D-15. ANALYSIS OF COLLOCATED 3M BADGES BY PEDCo AND TRW
(low PERC levels: Laundry A)

PEDCo

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
30.2	30.4		30.3	.1
21.9	41.7		31.8	14.0
42.3	41.2	30.5	38.0	6.5
47.4	68.2		57.8	14.7
16.7	15.6		16.2	0.8
83.7	23.1		53.4	42.8
72.6	52.2		62.4	14.4
32.4	85.3		58.9	37.5
56.5	46.9	39.0	47.5	8.8
65.8	62.3		64.1	2.5
56.4	20.5		38.5	25.4
31.9	52.6		42.3	14.6
28.7	25.0		26.9	2.6
94.4	94.8	95.9	95.0	0.8
70.7	71.1		70.6	0.3

C.V. = 25.3.

TRW

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
332	338		335	4.4
317	281		299	25.4
320	303		312	12.2
372	249		311	74.5
415	349	384	383	35.6

C.V. = 9.3%

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-16. ANALYSIS OF COLLOCATED 3M BADGES BY PEDCo AND TRW (high PERC levels: Laundry E)

PEDCo

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
6814	6528	6616	6653	146
6004	7782		6893	1257
2958	4853		3906	1340
3468	3597		3533	91
3335	3470		3403	95
2735	2211	2759	2568	310
4969	5325		5147	252
4346	7373		5860	2140
2427	2886		2657	325
5519	4827		5173	489
6118	6308	6308	6245	110
6017	3487		4752	1789
716	826		771	78
1506	1282	1521	1436	134
875	905		890	21
5948	4762	5391	5367	593
5994	3454	4624	4691	1271
4370	4588		4479	154

C.V. = 14.2%

TRW

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
11,293	7234	7361	8629	2304
6,886	5513	6718	6372	752
3,621	5542	5862	5008	1212

C.V. = 21.3%

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-17. ANALYSIS OF COLLOCATED DuPont BADGES BY PEDCo AND TRW (low PERC levels: Laundry A)

PEDCo

A, ppb	B, ppb	C, ppb	$\bar{X}$	SD
47.7	97.8		72.8[a]	35.4[a]
35.1	35.9		35.5	0.6
44.8	47.5		46.7	1.9
45.6	46.1	48.0	46.6	1.3
66.6	74.4		70.5	5.6
27.2	28.1		28.2	0.6
77.5	87.9		83.7	7.4
90.9	89.2	104	94.7	8.1
95.9	90.2		93.1	4.0
64.0	67.7		65.9	2.6
74.5	90.1		82.6	11.5
71.7	78.8		75.3	5.0
89.2	80.7		85.0	6.0
80.2	86.5		83.4	4.4
96.6	101		98.8	3.1

C.V. = 6.3%.

TRW

A, ppb	B, ppb	C, ppb	$\bar{X}$	SD
85.4	20.1	103	69.5	43.6
125	N.D.[b]	66.3	63.8	62.6
77.1	27.8		52.5	34.9
115	159		137.0	31.1
73.3	128	108	103.1	27.6
146	98	150	131.3	28.8

C.V. = 41.0%

[a] Excluded from calculation.

[b] None detected.

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-18. ANALYSIS OF COLLOCATED DuPont BADGES BY PEDCo AND TRW
(high PERC levels: Laundy E)

PEDCo

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
5368	5271		5320	686
7100	4363		5732	1937
3948	6002		4975	1453
3023	3192		3108	118
3170	4073		3622	637
2140	2224	2254	2206	60
4048	4094	4502	4216	249
3745	8180		5963	3136
3137	3137		3137	0
4741	4760		4751	14
4733	9599		7166	3440
3960	3897		3929	43
729	683		706	32
1971	1240		1606	517
769	786		778	12

C.V. = 21.6.

TRW

A, ppb	B, ppb	C, ppb	$\overline{X}$	SD
6491	7566		7079	759
9291	7435	6617	7781	1369
4761	5987	5519	5422	618
9848	9611	6662	8707	1776
5431	5658		5545	161
4427	4700		4564	192

C.V. = 12.5%

SD = Standard Deviation.
C.V. = Coefficient of Variation.

TABLE D-19. ANALYSIS OF y-INTERCEPT (STANDARD DEVIATION INTERCEPT) EQUIVALENCY TO ZERO WHEN STANDARD DEVIATION IS PLOTTED AGAINST CONCENTRATION

Table	Concentration range (ppb)		N[a]	y-intercept[b]	"t" value	$t_{0.975}$
	Low	High				
D-1	0.80	31.6	13	0.15	1.35	2.18
D-2	10.8	1,286	26	1.2	1.68	~1.96
D-3	0.50	9.2	6	0.06	1.22	2.57
D-4	11.9	1,725	10	-0.48	0.43	2.26
D-5[c]	N/A[c]	N/A[c]	4	0.03	0.76	3.18
D-6	19.7	1,464	5	5.6	0.42	2.78
D-7	0.05	16.0	38	-0.20	1.41	~1.96
D-8	40.2	14,295	32	-98.2	0.58	~1.96
D-9	0.45	2.86	5	0.36	0.92	2.78
D-10	115	975	7	42.5	1.55	2.45
D-15[d]	16.2	95.0	15	10.6	1.08	2.15
D-15[d]	299	383	5	45.8	0.33	2.78
D-16[d]	771	6,893	18	-28.2	0.08	2.11
D-16[d]	5,008	8,629	3	847.4	0.59	4.30
D-17[d]	28.2	98.8	14	-2.1	0.99	2.15
D-17[d]	52.5	137.0	6	59.2	2.01	2.57
D-18[d]	706	7,166	15	-897.9	1.76	2.15
D-18[d]	4,564	8,707	6	-1,678	1.96	2.57

[a] N = number of data sets involved in each table.

[b] For these determinations: y = standard deviation of each data set
x = mean concentration of each data set

[c] Test performed using standards not convertible to exact ppb equivalent. Range ratio ≃ 1:10.

[d] For Tables D-15 through D-18, first values listed are PEDCo results, second values listed are TRW results.

The coefficient of variation for a pooled data set can be determined according to the method presented on Page 49 if the standard deviation is proportional to the concentration throughout the concentration range. To test this condition, the standard deviations of each data set within a pooled data set are plotted to the mean concentrations of each data set. A test of the null hypothesis that the intercept is not significantly different from zero (95 percent confidence) is made by the following computation:

$$t_{0.975} > \frac{b}{Sy.x \sqrt{\frac{1}{N} + (\bar{x}^2 / \sum_{i=1}^{N} \chi^2)}}$$

where $t_{0.975}$ = Value from t table, p. 51 for N
N = Number of data sets
b = y intercept (y_i = standard deviation for each data set)
$\bar{x}$ = Mean concentration (x_i = mean concentration for each data set)
$\chi = x_i - \bar{x}$

$$Sy.x = \sqrt{(\sum_{i=1}^{N} y^2 - [(\sum_{i=1}^{N} xy)^2 / \sum_{i=1}^{N} x^2])/(N-1)}$$

The values determined above for each pooled data set are presented in Table D-19. In Table D-19, the values determined to compare with the $t_{0.975}$ values are listed under "t" value. As this table shows, the null hypothesis is verified for each data set.

APPENDIX E

SUMMARY OF QUALITY ASSURANCE SAMPLE RESULTS

TABLE E-1.
SUMMARY OF PERCHLOROETHYLENE QA SAMPLE RESULTS
(mean and CI_{95} values)

	Percent recovery		
	Outside tubes	Inside tubes	Badges
PEDCo	84.6 ± 8.9	86.4 ± 10.2	27.8 ± 8.7
TRW	67.8 ± 5.5	98.5 ± 2.9	43.3 ± 5.4
RTI	60.1 ± 1.7	88.1 ± 4.6	35.6 ± 2.4

TABLE E-2.
PEDCo
Perchloroethylene Outside Tube QA Sample Results

RTI ID#	PEDCo ID#	PEDCo Reported Value (Micrograms)	Expected Value (Micrograms)	Percent Bias	Percent Recovery
P-OT29	BJ686	2.96	4.64	-36.2	63.8
P-OT9	BJ678	4.77	6.64	-28.2	71.8
P-OT13	BJ680	0.46	6.50	-92.9	7.1*
P-OT2	BJ675	6.47	6.40	1.1	101.1
P-OT46	BJ693	4.63	4.57	1.3	101.3
P-OT21	BJ683	1.11	2.14	-48.1	51.9*
P-OT16	BJ681	6.40	6.40	0	100
P-OT39	BJ690	6.25	7.48	-16.4	83.6
P-OT18	BJ682	6.53	7.48	-12.7	87.3
P-OT43	BJ692	1.22	1.86	-34.4	65.6
P-OT4	BJ676	4.41	5.35	-17.6	82.4
P-OT36	BJ689	1.94	2.23	-13.0	87.0
P-OT42	BJ691	4.03	4.64	-13.2	86.8
				Average	84.6
					± 8.9

*Excluded from average

TABLE E-3.
PEDCo
Perchloroethylene Inside Tube QA Sample Results

RTI ID#	PEDCo ID#	PEDCo Reported Value (Micrograms)	Expected Value (Micrograms)	Percent Bias	Percent Recovery
P-IT35	BJ670	6749	11361	-32.7	67.3
P-IT49	BJ674	10390	14607	-28.9	71.1
P-IT24	BJ666	2257	3246	-30.5	69.5
P-IT28	BJ668	2042	3246	-37.1	62.9
P-IT19	BJ664	7706	11361	-32.2	67.8
P-IT2	BJ531	8202	8115	1.1	101.1
P-IT5	BJ533	8631	8115	6.4	106.1
P-IT3	BJ532	9995	11361	-12.0	88.0
P-IT26	BJ667	10894	14607	-25.4	74.6
P-IT1	BJ530	4225	3246	30.2	130.2
P-IT6	BJ534	1146	11361	-89.9	10.1*
P-IT7	BJ635	13870	14607	-5.1	94.9
P-IT16	BJ663	10939	11361	-3.7	96.3
P-IT40	BJ672	2713	3246	-16.4	83.6
P-IT10	BJ536	14029	14607	-4.0	96.0
P-IT11	BJ537	2791	3246	-14.0	86.0
				Average	86.4
					±10.2

*Excluded from average

TABLE E-4.

PEDCo

Perchloroethylene Badge QA Sample Results

RTI ID#	PEDCO ID#	PEDCo Reported Value (Micrograms)	Expected Value (Micrograms)	Percent Bias	Percent Recovery
P-B15	BJ654	744	2290	-67.5	32.5
P-B12	BJ653	575	1561	-63.2	36.8
P-B18	BJ655	531	1561	-66.0	34.0
P-B6	BJ648	0.1	0	0	0
P-B4	BJ647	845	1244	-32.1	67.9*
P-B9	BJ824	642	1824	-64.8	35.2
P-B8	BJ649	228	1244	-81.7	18.3
P-B28	BJ825	210	1824	-88.5	11.5
P-B25	BJ652	1462	1244	-62.9	37.1
P-B23	BJ651	310	1824	-83.0	17.0
				Average	27.8
					±8.7

*Excluded from average

TABLE E-5.
TRW
Perchloroethylene Outside Tube QA Sample Results
(GC/EC)

RTI ID#	TRW ID#	TRW Reported Value (Micrograms)	Expected Value	Percent Bias	Percent Recovery
P-OT12	1830	3.25	4.74	-31.4	68.6
P-OT25	1831	2.77	4.74	-41.6	58.4
P-OT35	1833	3.47	5.35	-35.1	64.9
P-OT10	1834	1.44	2.23	-35.4	64.6
P-OT5	1835	6.06	7.48	-19.0	81.0
P-OT8	1836	4.18	5.58	-25.1	74.9
P-OT27	1837	1.19	1.90	-37.4	62.6
P-OT17	1838	1.14	1.83	-37.7	62.3
P-OT15	1829	3.37	4.64	-27.4	72.6
				Average	67.8
					±5.5

TABLE E-6.
TRW
PERCHLOROETHYLENE INSIDE TUBE QA SAMPLE RESULTS
(GC/FID)

RTI I.D. No.	TRW I.D. No.	TRW reported value, μg	Expected value, μg	Bias, %	Recovery, %
P-IT39	1844	13,175	14,607	-9.8	90.2
P-IT15	1845	8,031	8,115	-1.0	99.0
P-IT50	1846	15,631	14,607	7.0	98.7
P-IT9	1847	13,141	11,361	15.7	98.5
P-IT13	1848	18,513	14,607	26.7	99.1
P-IT18	1849	10,536	8,115	29.8	93.5
P-IT25	1850	15,636	11,361	37.6	(137.6)[a]
P-IT27	1851	7,990	8,115	-1.5	88.5
P-IT22	1852	11,820	11,361	4.0	104.0
P-IT34	1853	8,546	8,115	5.3	105.3
P-IT14	1854	3,397	3,246	4.7	104.7
P-IT32	1855	11,270	11,361	-0.8	99.2
P-IT20	1856	14,767	14,607	1.1	101.1
P-IT41	1857	11,377	11,361	-0.1	99.9
P-IT37	1858	7,939	8,115	-2.2	97.8
			Average		98.5
					2.9 (CI_{95})

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[a] Excluded from calculation.

TABLE E-7.
TRW
Perchloroethylene Badge QA Sample Results
(GC/FID)

RTI ID#	TRW ID#	TRW Reported Value (Micrograms)	Expected Value (Micrograms)	Percent Bias	Percent Recovery
P-B3	1815	632	1824	-65.4	34.6
P-B7	1824	784	1294	-37.0	63.0
P-B24	1827	468	1244	-62.4	37.6
P-B22	1828	515	1244	-58.6	41.4
P-B14	1818	970	2290	-57.6	42.4
P-B19	1823	982	2290	-57.1	42.9
P-B38	1822	688	1561	-55.9	44.1
P-B11	1819	684	1561	-56.2	43.8
P-B16	1825	685	1561	-56.1	43.9
P-B43	1820	900	2290	-60.7	39.3
				Average	43.3 ±5.4

TABLE E-8.
RTI
Perchloroethylene Outside Tube QA Sample Results
(GC/EC)

RTI ID#	RTI Reported Value (Micrograms)	Expected Value (Micrograms)	Percent Bias	Percent Recovery
P-OT50	2.86	4.64	-38.4	61.6
P-OT47	3.16	5.35	-40.9	59.1
P-OT38	2.80	4.74	-40.9	59.1
P-OT20	3.24	5.35	-39.4	60.6
			Average	60.1
				±1.9

TABLE E-9.
RTI
Perchloroethylene Inside Tube QA Sample Results
(GC/FID)

RTI ID#	RTI Reported Value (Micrograms)	Expected Value (Micrograms)	Percent Bias	Percent Recovery
P-IT17	2828	3246	-12.9	87.1
P-IT44	2966	3246	-8.6	91.4
P-IT48	8863	11361	-22.0	78.0
P-IT23	13571	14607	-7.1	92.9
P-IT31	7409	8115	-8.7	91.3
P-IT43	7223	8115	-11.0	89.0
P-IT46	2825	3246	-13.0	87.0
			Average	88.1
				±4.6

TABLE E-10.
RTI
Perchloroethylene Badge QA Sample Results
(GC/EC)

RTI ID#	RTI Reported Value (Micrograms)	Expected Value (Micrograms)	Percent Bias	Percent Recovery
P-B1	471	1244	-62.1	37.9
P-B2	457	1244	-63.3	36.7
P-B5	673	1824	-63.1	36.9
P-B26	718	1824	-60.6	39.4
P-B27	375	1244	-69.9	30.1
P-B29	448	1244	-64.0	36.0
P-B30	669	1824	-63.3	36.7
P-B49	481	1561	-69.2	30.8
P-B50	567	1561	-63.7	36.3
			Average	35.6 ±2.4